Complex Surgical Repair of a Flail Tricuspid Valve After Chest Wall Trauma in a Pediatric Patient

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Traumatic injury to the tricuspid valve can result from severe nonpenetrating chest wall trauma. We present the case of an initially asymptomatic 11-year-old girl who was kicked in the chest by a horse. The trauma resulted in avulsed papillary muscles, ruptured chordae, and right heart failure. She underwent early tricuspid valve reconstruction and annuloplasty. We advocate for routine use of echocardiography to assess for traumatic injury to intracardiac structures. In addition, we believe that early surgical intervention may prevent right-sided heart dysfunction, atrial arrhythmias, and the need for valve replacement.

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raumatic injury to the tricuspid valve is rare but is associated with direct nonpenetrating chest trauma, most commonly motor vehicle accidents. The mechanism of injury is thought to be secondary to sudden impact causing an anteroposterior compression of the right ventricle by the sternum in end-diastole. The clinical presentation depends on the severity of the intracardiac injury and the degree of tricuspid regurgitation (TR). Many patients are initially asymptomatic from a cardiovascular perspective, although right heart failure, arrhythmias, and cyanosis eventually develop. In patients with severe TR, the progression of right heart failure may be quite rapid. Our patient is 1 of only a limited number of pediatric patients described in the literature [1], and this case is the first to highlight the use of 3-dimensional (3D) perioperative echocardiography. The mechanism of injury in this patient is unique and emphasizes the importance of having a high index of suspicion after blunt chest trauma [2–4].

A previously healthy 11-year-old girl presented to an outside hospital after she was kicked in the chest by a horse. She complained of mild chest pain. Physical examination was notable for hoof-shaped bruising of the lower sternum with tenderness to palpation and a

mild friction rub. Serologic test results were notable for elevated levels of creatinine kinase, troponin, and myoglobin. A chest roentgenogram did not demonstrate any rib fractures, and computed tomography showed a small pulmonary contusion and a small pneumatocele. The electrocardiogram and telemetry demonstrated normal sinus rhythm with an incomplete right bundlebranch block and occasional premature ventricular contractions. Because of laboratory evidence of myocardial injury and ventricular ectopy, transthoracic echocardiography (TTE) was performed. The echocardiogram demonstrated severe TR and severe leaflet prolapse that was concerning for rupture of the chordae to the anterior leaflet of the tricuspid valve. The right atrium and ventricle were also moderately dilated. She was discharged home to allow the myocardial contusion to recover, and she was to return for an operation in the following weeks.

On the day of discharge, she presented to our institution for a second opinion. Physical examination findings included hepatomegaly and jugular venous distention. TTE demonstrated a ruptured and flail chordae of the anterior leaflet of the tricuspid valve with prolapse and severe TR (Fig 1), a moderately dilated right atrium and ventricle, interventricular septal bowing into the left ventricle in diastole, and flow reversal in the inferior vena cava.

Given the extent of the injury and evidence of right heart failure, the patient was taken to the operating room the following day for complex repair of the tricuspid valve. Intraoperative transesophageal echocardiography (TEE) with 3D reconstruction demonstrated avulsion of the anterior papillary muscle with flail leaflet (Fig 2), not previously seen on TTE or cardiac magnetic resonance imaging. Additionally, there was poor coaptation of the anterior leaflet, and severe TR was again noted.

The operation was performed through a median sternotomy. On opening the pericardium, contusions were observed on the anterior free wall of the right ventricle and posterior wall of the left ventricle. The right side of the heart was massively enlarged. After aortic crossclamping, the tricuspid valve was inspected. All papillary muscles were completely or subtotally avulsed. Several chordal attachments were ruptured. Both the anterior and lateral leaflets were flail and the tricuspid valve annulus was dilated. The avulsed papillary muscles were reimplanted using a polytetrafluorethylene felt pledgeted suture. Ruptured chordae were reconstructed with Gore-Tex (W. L. Gore and Associates, Flagstaff, AZ) artificial chordae. A DeVega-type annuloplasty was performed.

The postoperative TEE demonstrated a well-suspended tricuspid valve without prolapse and trivial TR. The patient was extubated in the operating room and had an unremarkable postoperative course. Discharge TTE noted trivial TR and normal right ventricular size and function. It is currently 4 months after surgical intervention. She has good activity tolerance and is not taking any medication.

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Fig 1. Transthoracic echocardiogram (A) with and (B) without color flow mapping. There are flail chordae (arrow) to anterior tricuspid valve leaflet with severe prolapse and severe tricuspid regurgitation. Right atrium is moderately dilated.



Comment

Patients who sustain traumatic injury to the tricuspid valve and are initially asymptomatic may not necessarily be referred for cardiac imaging. This case highlights the importance of echocardiography to evaluate for tricuspid valve injury after severe blunt chest trauma, particularly in children. In addition to TTE, other forms of imaging (in particular TEE with 3D reconstruction) may be helpful to further define the exact injury to the tricuspid valve [5]. We advocate that all patients with a history of major blunt chest trauma should undergo echocardiography to rule out cardiac injury. Clinicians should be particularly suspicious in those who present with right bundlebranch block, significant ectopy, signs of right heart failure, or elevations in cardiac enzymes.

The surgical experience with traumatic tricuspid valve disease is limited [4, 6–8]. Historically, the development of right heart dysfunction has been the accepted indication for surgical intervention. We believe that early repair was advantageous in this patient. Delaying surgical intervention may lead to progressive valve distortion at the time of repair, development of irreversible right heart dysfunction, and arrhythmias. In adult case series, patients whose operations were delayed were often found to have contracted and atrophied papillary muscles, chordae tendinae, and valve leaflets, which ultimately led to valve replacement [7, 8]. A previous series with a mean time to operation of 16 years reported that 20% of patients required valve replacement [8]. In comparison, a case series with time to operation of approximately 3 years achieved valve repair in all 13 patients. This point is of particular interest in the pediatric population, because valve replacement is associated with high failure rates and the added risk of thromboembolic events. Accordingly, every effort to achieve a valve repair should be made.

The most common anatomic injury is chordal rupture, particularly of the anterior leaflet [7]. The advent of modern surgical materials and techniques has allowed more patients to avoid valve replacement. Accepted surgical techniques include chordal replacement, suturing of torn leaflets, and suspension of flail leaflets [7]. In all cases, the tricuspid valve annulus is dilated and requires annuloplasty. The De Vega-type annuloplasty is the

Fig 2. (A, B) Three-dimensional transesophageal echocardiogram. Anterior papillary muscle is completely avulsed from right ventricle and flails into right atrium in systole. There is poor coaptation of anterior leaflet. Asterisk represents avulsed papillary muscle of anterior leaflet. (RA = right atrium; RAA = right atrial appendage; RV = right ventricle.)



preferred method in children and adolescents with need of somatic growth.

In conclusion, clinicians should have a high index of suspicion for intracardiac injury in pediatric patients with blunt chest trauma. We advocate that all patients who experience severe chest wall trauma undergo echocardiography to evaluate for cardiac injury. Advanced imaging, including TEE with 3D reconstruction, may be helpful in defining the injury. Early surgical intervention may prevent right-sided heart dysfunction, atrial arrhythmias, and the need for valve replacement.

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