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# Delayed Presentation of Traumatic Pericardial Rupture: Diagnostic and Surgical Considerations for Treatment

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## ABSTRACT

Traumatic pericardial rupture is a rare event with high mortality. We present the case of a 15-year-old boy who sustained thoracic and abdominal trauma secondary to motor vehicle collision, with a delayed diagnosis of traumatic pericardial rupture with cardiac herniation. Out of concern for torsion and hemodynamic collapse, surgical repair was advised. We have developed a novel surgical approach to this rare condition, utilizing a combination of thoracoscopic and open surgical techniques. The guiding principles of our repair include the utilization of fenestrated pieces of bovine pericardium to create a tension free repair, minimizing the likelihood of pericardial effusion, and returning the cardiac mass to normal anatomic position.

## CASE PRESENTATION

Our patient is a 15-year-old boy who was a restrained passenger in a motor vehicle collision. He was brought to an outside hospital where he was hemodynamically stable. Radiographic findings included a mid-sternal facture, clavicular fractures, and bilateral rib fractures. A computed tomography (CT) scan of the chest and abdomen were remarkable for a large retrosternal hematoma, without noted sinus tachycardia or non-specific T wave abnormalities. He was admitted to the pediatric intensive care unit (PICU) for monitoring.

On post-trauma day one, he was noted to have a persistent tachycardia and unchanged electrocardiogram (EKG). Cardiology consultation was obtained, and a trans-thoracic echocardiogram (TTE) was performed. The TTE demonstrated a circumferential pericardial effusion with evidence of moderate right ventricular dilation and depressed right ventricular function. Left ventricular function was normal. The cardiac mass appeared within the mediastinum in the normal anatomic position.

The patient remained hemodynamically stable and was transferred from the PICU to the ward on post-trauma day two. TTE was repeated, with significant improvement in right ventricular function, resolution of the pericardial effusion, and normal anatomic location of the heart.

The patient recovered from his injuries and was discharged home on post-trauma day seven. He returned for out-patient cardiology follow-up two weeks later and was asymptomatic. Repeat TTE noted his cardiac mass was now found to be shifted and rotated leftward, with the apex at the mid-axillary line near the fifth intercostal space. The descending aorta encroached into the left atrium, however, no obvious obstruction of the great vessels, coronary arteries, or pulmonary veins was appreciated. The images were concerning for a delayed diagnosis of traumatic pericardial rupture with cardiac herniation.

He was referred to Boston Children's Hospital (BCH) for further diagnostic workup and possible surgical intervention. Cardiac magnetic resonance imaging (MRI) was obtained. The MRI demonstrated that the heart had shifted posteriorly with ensuing distortion of the right ventricular free wall at its midpoint, consistent with traumatic pericardial rupture and cardiac herniation (Figure 1). Despite his clinical stability, the concern for torsion of the great vessels with resultant cardiogenic shock and cardiovascular instability was significant, and surgical repair was offered.

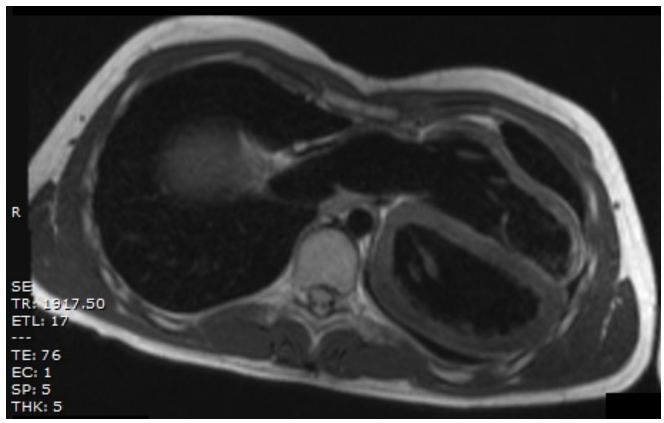


Figure 1. MRI demonstrating cardiac herniation into the left chest.

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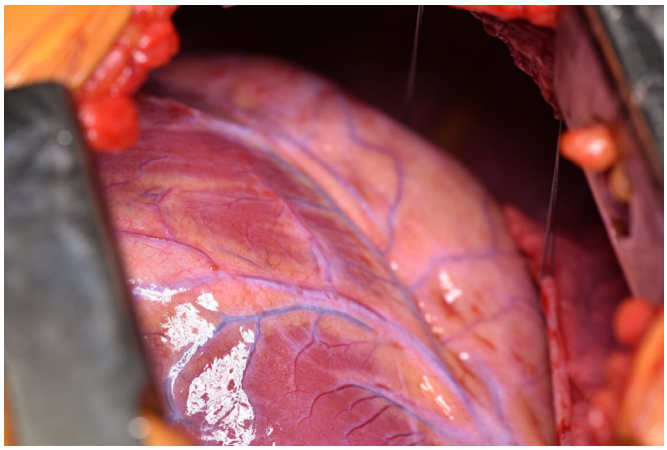

Figure 2. Intra-operative photo demonstrating the lateral aspect of the pericardial tear. Pericardial edge is marked by stay sutures.

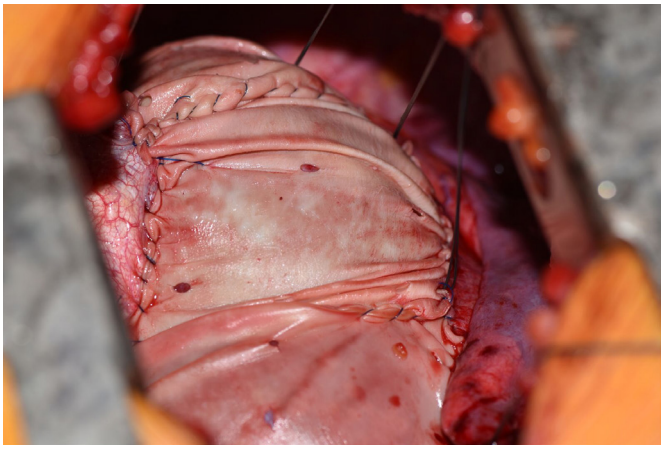

Figure 3. Photo of the final repair. Three 6 cm x 8 cm pieces of fenestrated bovine pericardium have been sutured in place to create a tension free repair. The cardiac mass was returned to the mediastinum.

The patient was brought to the operating room and induced without difficulty. A double lumen endotracheal tube for lung isolation was placed. He was positioned in the right lateral decubitus position. We began with diagnostic thoracoscopy to define the pericardial anatomy. The camera was inserted and we appreciated almost the entirety of the cardiac mass herniated into the left chest. An approximately 20 cm pericardial tear was noted, in a posterior location above the pulmonary veins. The pericardial edges were torn along the path of the left phrenic nerve, which was spared, extending inferiorly to the diaphragmatic reflection (Figure 2). Given this location, we chose the fifth interspace to perform a posterolateral thoracotomy. The pericardial edges were dissected free. Given the massive size of the defect, closing the pericardium primarily would have resulted in an unacceptable amount of tension on the closure. As a result, we elected to reconstruct the pericardial defect with the use of fenestrated bovine pericardial patches. A total of three 6 cm x 8 cm individual bovine pericardial patches were

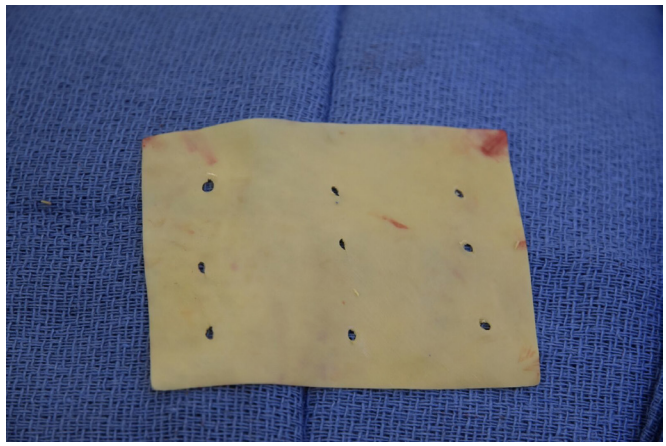

Figure 4. 6 cm x 8 cm bovine pericardium. Fenestrated with the use of a 1.7 mm punch.

utilized and secured to the pericardial edges with the use of a running 4-0 prolene suture. At the conclusion of the repair, the heart was returned to its normal anatomic location (Figure 3).

The patient tolerated the procedure well. A single chest tube was placed in the left hemithorax and the posterolateral thoracotomy was closed. The patient was extubated in the operating room and transported to the cardiac intensive care unit (CICU) in stable condition. Post-operative TTE demonstrated a normally positioned heart in the mediastinum, normal systolic function, and no pericardial effusion. The patient's post-operative course was uneventful, and he was discharged home on post-operative day six.

## DISCUSSION

Pericardial rupture is a rare injury following blunt trauma with potentially fatal consequences, with most cases diagnosed at the time of autopsy [Nan 2009; Levine 1995] . In a series of trauma victims who survived the initial insult and were diagnosed with pericardial rupture, mortality was high (25%), likely due to associated injuries and cardiac contusion [Janson 2003]. The major concern associated with pericardial rupture is cardiac herniation and death, occurring due to torsion or incarceration of the great vessels, leading to cardiopulmonary collapse [Glotzer 2014].

The diagnosis of pericardial rupture is difficult and requires a high degree of clinical suspicion [Piazza 2002; Levine 1995]. Chest radiographs may demonstrate displacement of the cardiac silhouette, but with associated traumatic injuries, this may be challenging to appreciate. While increasing numbers of patients receive CT scans in the peri-trauma period, not all patients, like ours, will demonstrate pericardial injury at the time of initial imaging [Rashid 2003]. Additionally, echocardiography may be non-diagnostic, given the changes in cardiac orientation depending upon patient positioning. In this case, we found cardiac gated MRI to be exceptionally helpful in validating a suspected diagnosis of pericardial rupture in an otherwise asymptomatic patient [Rashid 2003].

Due to the rarity of this clinical situation, many surgical approaches have been utilized, including median sternotomy, posterolateral thoracotomy, and minimally invasive thoracoscopic approaches [Kamiyoshihara 2016]. While there are proponents of each approach, surgical principles guiding the repair remain the same: exposure must be excellent, and a tension free repair must be obtained.

With this in mind, we have developed a surgical approach that is unique, reliable, and reproducible in the setting of traumatic pericardial rupture. We have identified important components in the pre-operative, intra-operative, and peri-operative period that we believe contribute to a successful surgical outcome. With respect to anesthetic management, single lung ventilation with the use of a double lumen endotracheal tube is a necessity. With lung isolation, the working space in the hemithorax is greatly enhanced, allowing for identification of the ruptured pericardial edges and ease of repair. Next, confirming the diagnosis of pericardial rupture with diagnostic thoracoscopy provides the surgeon with the ability to localize the pericardial tear. This facilitates selection of the appropriate interspace by which to create a full posterolateral thoracotomy for definitive repair. Once the interspace has been selected and the posterolateral thoracotomy undertaken, freeing the entirety of the pericardial edge to develop a healthy rim of tissue for definitive repair is crucial.

With respect to repairing the defect, many authors have advocated for primary repair using either an interrupted or running suture. In our experience, given the rather sizable nature of the pericardial tear when presenting with cardiac herniation, primary repair of the pericardial edges would create undo tension, possibly leading to restrictive physiology and a high likelihood of failure. As a result, we have developed the technique of utilizing fenestrated bovine pericardial patches in order to return the heart to its normal anatomic position without tension (Figure 4). Creating fenestrations allows for any pericardial fluid which may accumulate to drain into the pleural space and be captured by the chest drain, therefore negating the possible complication of pericardial effusion tamponade physiology. Post-operatively, EKG should be performed to confirm the adequacy of the repair, and repeated at time of discharge.

## CONCLUSION

Traumatic pericardial rupture is a rare injury following blunt trauma. The clinician must have a high index of suspicion for pericardial rupture if associated blunt abdominal and thoracic injuries are encountered in the trauma patient. When suspected, a low threshold for obtaining cardiac MRI for diagnostic purposes is prudent. In the setting of cardiac herniation, the risk of torsion of the great vessels and subsequent cardiopulmonary collapse drives the decision for surgical repair. The principles of surgical repair include lung isolation with the use of double lumen endotracheal tube, diagnostic thoracoscopy to identify the pericardial tear and plan the location of posterolateral thoracotomy, and a tension free repair with the use of fenestrated bovine pericardial patches, allowing the heart to be returned to its normal anatomic location and minimizing the post-operative collection of pericardial fluid.

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