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Case Report

Acute cardiogenic shock secondary to blunt traumatic aortic valve injury

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ABSTRACT

Background: Blunt cardiac injuries rarely result in aortic valve cusp rupture, leading to acute aortic insufficiency and cardiogenic shock. This rare clinical entity carries a high mortality rate if left undiagnosed and not managed surgically, with few patients surviving beyond 24 h. It presents a diagnostic challenge in the polytrauma patient in shock, with multiple possible and complementary etiologies.

Case presentation: We present a 56-year-old male with persistent hypotension, a wide pulse pressure, and elevated serum troponin levels suggesting blunt cardiac injury after a motor vehicle accident. Transthoracic and transesophageal echocardiography revealed normal biventricular function but severe aortic insufficiency due to prolapse of the left coronary cusp.

He was taken emergently to surgery, where aortic valve exploration revealed complete left coronary cusp avulsion from the aortic annulus with a mid-cusp tear, requiring aortic valve replacement with a bioprosthetic valve. Postoperative echocardiography showed normal biventricular function with a well-seated bioprosthetic aortic valve with no insufficiency.

Conclusions: Traumatic aortic valve injury can lead to torn or prolapsed cusps causing acute aortic insufficiency leading to cardiogenic shock, but early recognition with appropriate and targeted diagnostic imaging is vital to prevent rapid patient deterioration and demise.

Background

Cardiac valve rupture caused by blunt chest trauma is rare and unusual [1,2], with less than 100 cases reported in the literature [3]. The most frequently involved valve appears to be the aortic valve [4], followed by mitral and tricuspid valves [2]. We present the case and successful surgical management of a patient that sustained a motor vehicle accident resulting in acute aortic valve injury with associated severe insufficiency, leading to acute cardiogenic shock.

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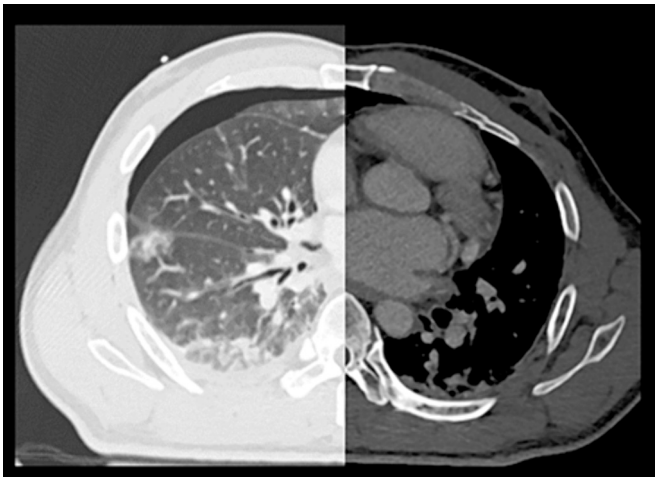

Fig. 1. Cross sectional CT displaying right pneumothorax with left mediastinal shift as well as left anterior rib fracture.

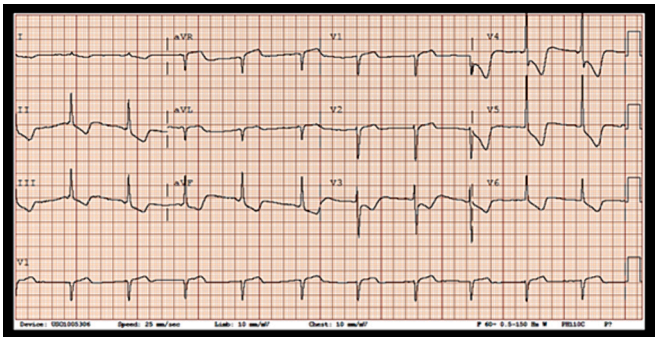

Fig. 2. The 12 lead ECG demonstrates marked down-sloping ST depression in the inferior and anterolateral precordial leads suggestive of global ischemia.

Case presentation

A 56-year-old male driver was involved in a severe multi-car motor vehicle accident requiring prolonged extrication. He was initially transported to a peripheral hospital where was noted to have decreased bilateral breath sounds, hypotension with a blood pressure of 86/37 mmHg, an oxygen saturation of 88 %, and a Glasgow Coma Scale (GCS) of 14. He was stabilized with a unit of uncrossmatched packed red blood cells, supplemental oxygen, immobilization and was transported by rotary-wing helicopter to our level 1 trauma institution for further care.

On arrival, his vital signs were unchanged. Physical examination was significant for right clavicular deformity and a 3/6 diastolic murmur best heard over the aortic valve. A computed tomography (CT) trauma scan revealed a right clavicular fracture, a manubrial fracture with an anterior mediastinal hematoma, multiple bilateral rib fractures, and a right-sided pneumothorax with leftward mediastinal shift (Fig. 1).

A 12-lead electrocardiogram (ECG) showed deep inverted T-waves in the inferior precordial leads (II, III, aVF) with a 3–4 mm of ST depression in the anterior precordial leads suggesting inferior and posterior wall ischemia (Fig. 2).

Despite active crystalloid resuscitation, the patient remained hypotensive with a blood pressure of 109/38 mmHg with a wide pulse pressure, and a norepinephrine infusion was started. However, due to persistent hypoxemia, he required endotracheal intubation. An emergent transthoracic echocardiogram (TTE) showed normal biventricular function with an ejection fraction (EF) of 55–65 %, and severe aortic insufficiency with prolapse of the left coronary cusp and premature closure of the mitral valve with associated diastolic mitral regurgitation (Fig. 3A and B).

These TTE findings were further characterized with an emergent transesophageal echocardiogram (TEE) which confirmed the severity of the AI due to the prolapse of the left coronary cusp with a defect between the left coronary cusp and the aortic annulus (Fig. 3C, D E, and F), which was further detailed on three-dimensional (3D) TEE imaging (Fig. 3G).

The cardiac surgery team was immediately consulted. Given his continued vasopressor requirement, the presence of acute severe aortic insufficiency, and cardiogenic shock, the patient was emergently taken to the operating room for emergent surgical intervention.

A midline median sternotomy was performed, with central cannulation for cardiopulmonary bypass, and the heart was arrested

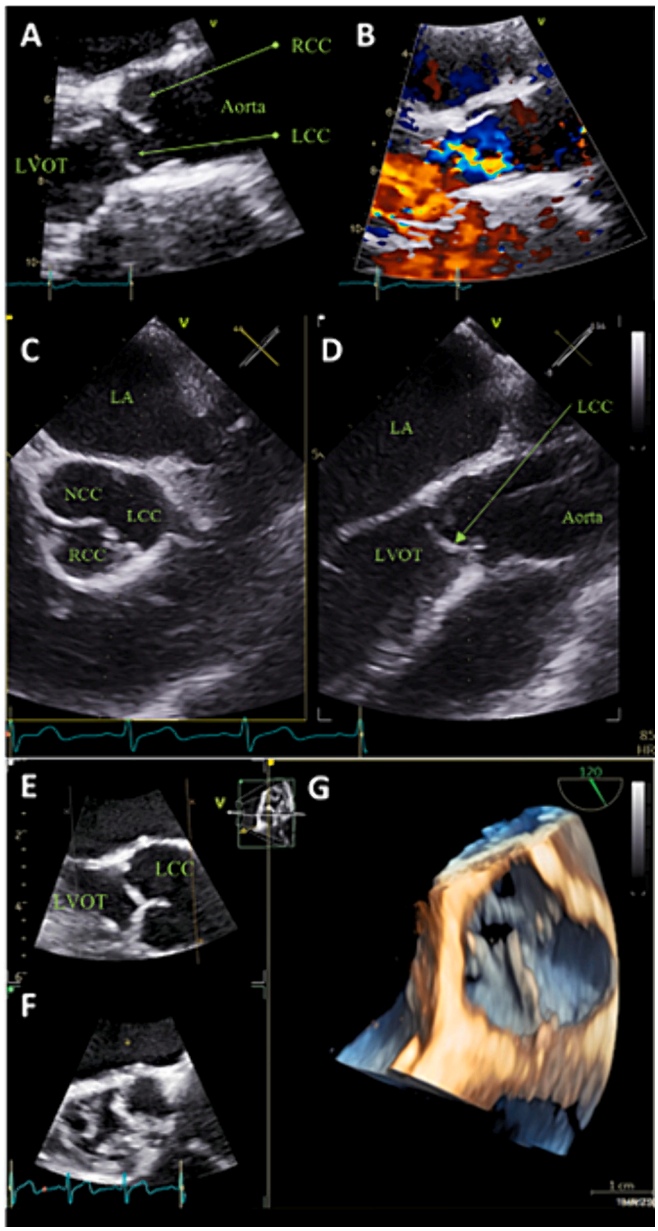

Fig. 3. TTE images displaying prolapse of the left coronary cusp below aortic annulus with eccentric aortic insufficiency (A, B). TEE images displaying prolapse of the left coronary cusp below the aortic anulus with non-coaptation of the right and left coronary cusps (C, D). TEE images showing a defect between the annulus and the LCC (E, F), with a 3-D image of the aortic valve (G). RCC = Right coronary cusp, LCC = Left coronary cusp, LVOT = Left ventricular outflow tract, NCC = Noncoronary cusp, LA = Left atrium.

with both retrograde and direct ostial cold blood cardioplegia. A transverse aortotomy allowed inspection of the aortic valve and showed an intact right and noncoronary cusp but a near total avulsion of the left coronary cusp from the aortic annulus with an associated mid-cusp tear (Fig. 4).

The aortic valve was deemed to be irreparable, and an aortic valve replacement was performed with a 23 mm Carpentier-Edwards™ PERIMOUNT Magna Ease aortic pericardial valve (Edwards Lifesciences Corporation, Irvine, CA, USA). Postoperative TEE imaging showed a well-seated aortic valve and no evidence of a perivalvular leak. The patient was weaned from cardiopulmonary bypass without any difficulty. His post-operative course was relatively uneventful, and with the orthopedic service managing his clavicular fracture and the acute anesthesia pain service managing the pain from his multiple rib fractures. He was discharged home on postoperative day 12.

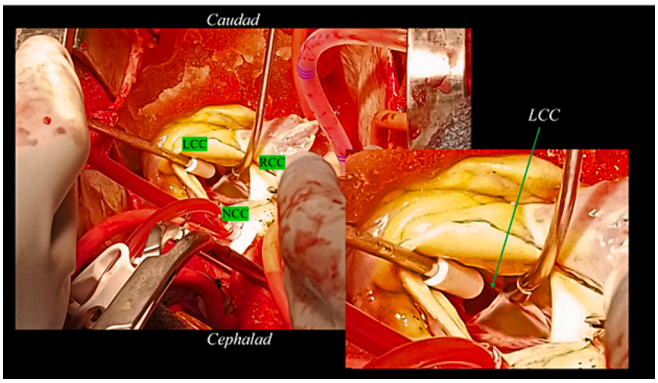

Fig. 4. Intraoperative photo showing avulsion of the left coronary cusp from annulus. LCC = Left coronary cusp, RCC = Right coronary cusp, NCC = Noncoronary cusp.

Discussion

Blunt chest trauma is estimated to be present in approximately 15 % of motor vehicle accidents [4], and can lead to various orthopedic, tracheobronchial, pulmonary, vascular, and cardiac injuries. Cardiac injuries are particularly concerning as they can encompass pericardial rupture, myocardial contusions, blunt coronary artery injury, cardiac chamber rupture, septal rupture, and valvular injuries, many of which are catastrophic and result in rapid demise without immediate intervention [4,5].

First described by Penderleath in 1830 [6], aortic valve injuries due to blunt chest trauma are largely related to motor vehicle accidents with most affecting the noncoronary cusp as a tear or an avulsion of the cusp or commissure [7,8]. The mechanism of injury of traumatic aortic valve rupture is thought to be due to a rapid increase in pressure in the aorta during early diastole, when the aortic valve is closed, the left ventricle is at minimal pressure, and the aorta is at maximal tension [9]. The sudden rise in aortic pressure from external compression or trauma then causes rupture and avulsion of the aortic valve [10]. After rupture, signs and symptoms can range from a wide pulse pressure, acute heart failure, and rapid decompensation to a slow deterioration of cardiac function over the course of weeks to months [4,5,11], sometimes years [12].

Early identification of aortic injury can facilitate intervention and prevention of long-term cardiac damage and death. However, in the case of the polytrauma patient, the clinical picture presents a diagnostic challenge, as shock can result from multiple possible mechanisms and injuries. Therefore, a thorough assessment with a physical exam through auscultation, electrocardiography with Doppler and color flow imaging, cardiac enzyme markers, and hemodynamic monitoring can assist practitioners in deciphering this difficult predicament [5]. In patients with clear signs of shock or acute heart failure due to valve rupture, open surgical intervention on cardiopulmonary bypass with full heparinization should be undertaken, barring any absolute contraindication to intravenous heparin caused by other severe injuries, with excellent long-term outcomes [10].

Most of the reported aortic valve injuries due to blunt trauma have been managed by aortic valve replacement with either a mechanical or a bioprosthetic valve. However, many have managed such injuries with successful aortic valve repairs citing excellent long term outcomes [3,10,13–15], as the repaired valves carry a lower risk of endocarditis and thromboembolism, and do not require long term anticoagulation especially in the younger patients. Our patient underwent an emergent aortic replacement as his aortic valve rupture pathology, compromising both a near total avulsion of the left coronary cusp from the aortic annulus and a mid-cusp tear, did not lend itself to a straightforward repair.

Conclusions

Aortic valve injuries due to blunt chest trauma are rare and can be managed surgically in the acute setting with either aortic valve repair or replacement. Recognizing such valvular injuries can be challenging in polytrauma. We emphasize that early recognition and prompt echocardiography can identify such acute valvular pathology, allowing for early intervention and improved clinical outcomes.

Abbreviations

GCS	Glasgow Coma Scale
CT	computed tomography
ECG	electrocardiogram
mm	millimeter
mmHg	millimeters of mercury
TTE	transthoracic echocardiogram
EF	ejection fraction
TEE	transesophageal echocardiogram

3D three dimensional
Mcg/min micrograms per minute

Ethics approval and consent to participate

Not applicable.

Consent for publication

NO informed consent was needed from the patient for the publication of this case report and any accompanying images.

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Declaration of competing interest

The authors declare that they have no conflicts of interest.

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