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Case Report

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Cardiac tamponade due to right atrial rupture

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Abstract:

Cardiac tamponade is a cardiac emergency that requires urgent intervention. Cardiac tamponade due to penetrating cardiac injury requires urgent thoracotomy. As per the guidelines, pericardiocentesis can be done as a bridge to thoracotomy. However, no clear guidelines exist on the management of cardiac tamponade due to blunt cardiac injury. In the following case report, we propose a management plan for blunt cardiac injury in the emergency department. In the following case report, we describe a patient with a road traffic accident who had a blunt cardiac injury and had cardiac tamponade for whom we did not do emergency pericardiocentesis. Instead, we managed the patient with iv fluids and blood transfusion and the patient was taken up for immediate emergency thoracotomy. Not all cardiac tamponade requires pericardiocentesis. Cardiac tamponade due to injury to the low-pressure system can be best managed by initial resuscitation followed by emergency thoracotomy. We also propose a management plan for managing a patient with cardiac tamponade due to blunt cardiac injury when the injury can be visible in the low-pressure chambers.

Keywords:

Blunt cardiac injury, cardiac, echocardiography, pericardiocentesis, right atrial rupture, serial pressure gradient measurement, tamponade, thoracotomy

Introduction

Cardiac tamponade is a cardiac emergency that can be due to a medical cause or traumatic cause.[1] Whatever the cause may be, the treatment of choice is emergency pericardiocentesis.[2] Cardiac tamponade leads to an increase in the pressure inside the pericardium, leading to compression of the free walls of the right atrium and ventricle (RA and RV), especially during the diastolic phase.[3] This, in turn, leads to impaired filling of the RA and RV as both the atrium and ventricle do not relax properly, leading to obstructive shock. The physiological basis of pericardiocentesis is to relieve the pressure effect on the RA and RV to relieve the obstructive shock. However, when the pericardial effusion is due to a tear in the RA, even if we do pericardiocentesis, there will be a leak of blood from RA into the pericardial space, leading to impaired filling of the RV and obstructive shock. If we don't do a pericardiocentesis, the pressure inside the pericardial sac creates a tamponade effect, leading to a decrease or stopping of blood flowing from RA to the pericardial sac.[3]

Case Report

A 27-year-old male patient presented to our emergency department with an alleged history of a road traffic accident when he traveled in a two-wheeler hit by another two-wheeler at high velocity. He

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was initially taken to a nearby secondary care center. A primary survey was done in the secondary care center, and they have intubated the patient in view of low Glasgow Coma Scale. They initiated two large bore iv lines, started the patient on 1 l of warmed crystalloids, and referred the patient to our tertiary care center. In our triage, the patient's vitals were heart rate 117 beats/min, blood pressure 80/50 mm of Hg, and hence, he was triaged as Emergency Severity Index Class II and was shifted to our resuscitation area. In our resuscitation area, we again carried out the primary survey. The airway was already secured with an 8.0 size endotracheal tube. There were no tube displacement, obstruction, pneumothorax, or equipment failure. The patient had bilateral equal air entry without any tracheal shift or distended neck veins, and the patient maintained a saturation of 100% with 40% FiO2. The patient's blood pressure was 80/50 mm of Hg with a heart rate of 117 beats per minute. There were no externally visible bleeding sites. Chest compression and pelvic compression were negative. There was no evidence of a long bone fracture. An extended Focussed Assessment of Sonography in Trauma was carried out, which revealed a circumferential pericardial effusion. Meanwhile, we initiated a group-specific blood transfusion. The patient's blood pressure stabilized after two units of blood transfusion.

A more detailed echocardiographic assessment was made. There was a circumferential pericardial effusion of 2 cm with evidence of RV diastolic collapse suggestive of cardiac tamponade. The patient also had a tear in the right atrial free wall [Figure 1a] with blood flow from the RA into the pericardial sac [Figure 1b]. We didn't proceed with pericardiocentesis because of two reasons. (1) There was very minimal space between the pericardial layers and there was a high chance of puncturing the myocardium. (2) With time, the pressure inside the pericardial sac gradually increased, which reduced the amount of blood flow from the RA into the pericardial sac. We used serial echocardiographic measurements of the pressure difference across the tear. Initially, the pressure difference across the site was 4 mm Hg, and at one point in time, the gradient became <1, which signifies that the leak across the tear was minimal [Figure 1c].

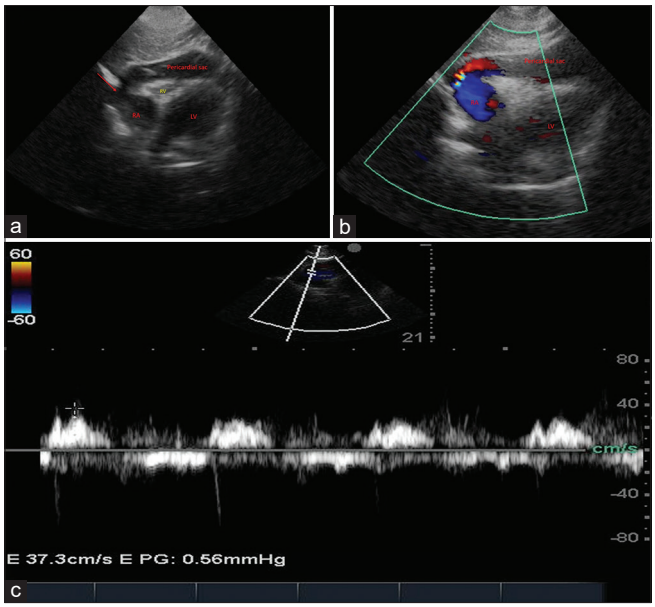

Figure 1: (a) Showing POCUS-Subcostal view. The arrow indicates the tear in the right atrium. (b) Showing POCUS-Subcostal view. The image shows a flow from right atrium into the pericardial sac at the site of rupture. (c) Shows the gradient across the pericardium and the right atrium across the rupture site

Once the patient was hemodynamically stable, the patient was taken up to radiology for contrast-enhanced computed tomography (CECT) of the thorax and abdomen by the cardiothoracic vascular team. In the CECT also, there was no contrast leak into the pericardium, which confirmed our hypothesis. The patient was taken to the operating room (OR) for emergency thoracotomy. In the OR, the tear in the RA was confirmed and then was repaired with prolene pledgeted sutures. Following the procedure, the patient was admitted to the intensive care unit. The patient was extubated the next day, and he was hemodynamically stable. The patient was subsequently discharged without any significant complications. We got informed written consent from the patient for publishing the case details and images.

Discussion

Cardiac tamponade is a condition wherein there is a collection of fluid in the pericardial space. It is caused by a variety of conditions, both medical and traumatic. The most common medical condition for cardiac tamponade is tuberculosis, followed by malignancy, postcardiac myocardial rupture, uremia, and coagulopathy.[4,5] The treatment for cardiac tamponade is urgent pericardiocentesis.[6]

Whereas cardiac tamponade due to trauma can be due to rupture of the cardiac chambers. If it is due to a rupture of the ventricle, usually the patient will not survive because of exsanguinating hemorrhage. Cardiac tamponade due to RA rupture results in both cardiogenic and obstructive shock. As per the 2015 ESC guidelines for the diagnosis and management of pericardial disease, the treatment of choice for cardiac tamponade due to penetrating trauma is immediate thoracotomy (Class I recommendation, level B of evidence).[7] When immediate thoracotomy is not possible, pericardiocentesis can be done as a bridge to thoracotomy (Class IIb recommendation, level B of evidence).[7] However, doing a pericardiocentesis in a patient with a rupture of the atrium may be detrimental.[3] Reddy *et al*. studied the spectrum of

hemodynamic changes in cardiac tamponade. In their study, they encountered a subgroup of patients who had low-pressure tamponade. They found that in this subgroup, pericardiocentesis was associated with an insignificant increase in cardiac output. They concluded that patients with equilibrated but low filling pressure may or may not have compromised cardiac output depending on whether the low pressure is secondary to hypovolemia. With the advances in diagnostic modality and point-of-care ultrasound, pericardiocentesis can be avoided if we can diagnose atrial rupture.

The pericardium is made up of fibrous tissues which have some elasticity. The pressure inside the pericardium starts to increase slowly when there is an accumulation of fluid inside the pericardial cavity. When the elastic limit is reached, further fluid accumulation causes an exponential increase in the pressure inside the pericardial cavity.[1,8] In traumatic cardiac tamponade due to right atrial rupture, an artificial shunt is created between the RA and the pericardium. The pressure inside the pericardial sac slowly rises as blood leaks into the pericardial cavity.

The normal pressure range inside the RA is 0–8 mm of Hg.[9,10] When the pericardial pressure rises above the RA pressure, the leak into the pericardial sac will decrease, and at one point in time, the leak becomes very minimal [Figure 2]. The pressure gradient across the rupture site can be measured using a pulsed-wave Doppler. When we do a pericardiocentesis to relieve the pressure inside the pericardial sac, again, the pressure inside the pericardial sac decreases and the gradient across the rupture site decreases. This will lead to further loss of blood which may exaggerate the hemorrhagic shock [Figure 3]. Thus doing a pericardiocentesis in a patient with RA rupture can be detrimental. De Maria *et al*. reported a case of right atrial rupture following blunt chest trauma. They also managed the patient by not doing pericardiocentesis and took the patient to OR for emergency thoracotomy. They also used transfusion of crystalloids and blood to restore hemodynamic stability in the acute phase.[11] A case report by Feola *et al*. on isolated right atrial rupture due to blunt chest injury revealed that the patient's hemodynamics worsened after pericardiocentesis.[12] Maraqa *et al*. also reported a case of isolated right atrial rupture, and they conducted a systematic review of isolated right atrial rupture. They also concluded that immediate operative intervention is needed for patients with hemodynamic instability.[13]

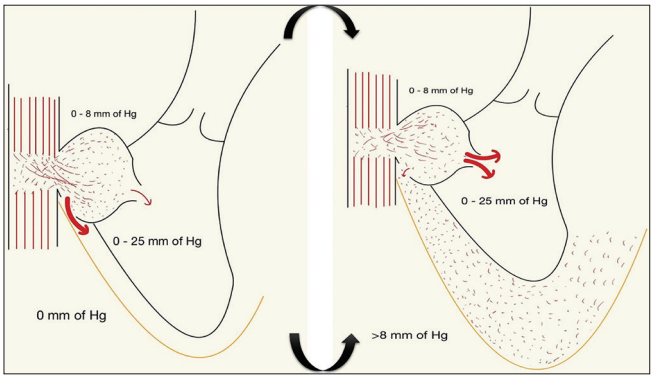

Figure 2: Shows the pressure of right atrium, right ventricle ventricle and pericardial sac and hemodynamics when rupture of low pressure system occurs

From this case, we suggest that in a patient with blunt thoracic injury with right atrial rupture causing cardiac tamponade, pericardiocentesis may not be required as the RA is a low-pressure system that results in the early stage stoppage of leak due to a decrease in the pressure gradient across the rupture site. Serial measurements of the pressure gradient across the rupture site for quantifying the magnitude of hemorrhage into the pericardial sac should be done. Adequate fluid and blood product transfusion may be required to achieve hemodynamic stability.[14] Early thoracotomy may be needed, and pericardiocentesis need not be tried as a bridge to thoracotomy. If pericardiocentesis is attempted, it may increase the hemorrhage.

Conclusion

There are no clear-cut guidelines regarding the management of cardiac tamponade due to blunt cardiac injury. This case highlights the importance of further research in blunt cardiac injury and a need for guidelines regarding the management of cardiac tamponade due to blunt cardiac injury.

Credit author statement

GR: Conceptualization, Resources, Writing-original draft, Writing - Reviewing and Editing, Visualization.

GRB, VC, RK: Resources, Writing, Reviewing.

BN: Writing – Extensive Review and Editing

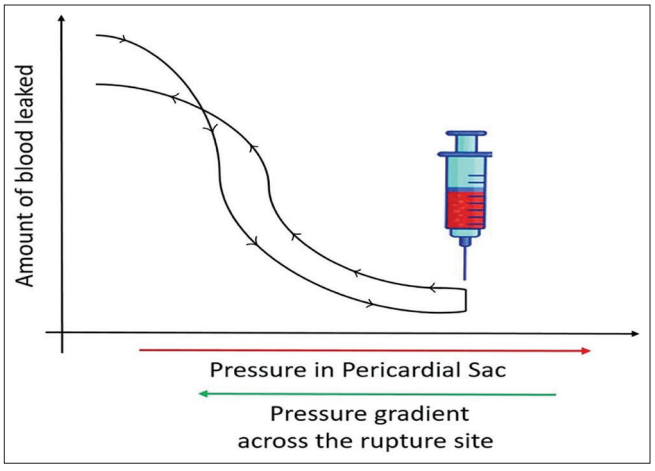

Figure 3: Graphical relationship between the amount of blood leaked into the pericardium and the pericardial pressure and the pressure gradient across the rupture site

Authors' contribution
All the authors have read and approved the manuscript. GR: Conceptualization, Resources, Writing-original draft, Writing - Reviewing and Editing, Visualization. GRB, VC and RK: Resources, Writing, Reviewing. BN: Writing – Extensive Review and Editing.

Conflicts of interest
None declared.

Ethics approval and consent to participate
We approve that institution does not require IRB approval for case reports and images.

Consent for publication
We got informed written consent from the patient for publishing the case details and images.

Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient understand that name and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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