Shockwave cardiac injury in thoracoabdominal gunshot wound

Weludo Ngwisanyi*, Shirley F.A.P. Moeng, Maeyane Moeng

Department of Surgery, University of the Witwatersrand, South Africa

A R T I C L E   I N F O

Article history:
Received 16 January 2021
Received in revised form 16 February 2021
Accepted 18 February 2021
Available online 22 February 2021

Keywords:
Case report
Shockwave injury
Dressler syndrome
Cardiac window
Gunshot to thoracoabdomen
Cardiac tamponade

A B S T R A C T

INTRODUCTION AND IMPORTANCE: Cardiac injuries are associated with high mortality rates and most affected individuals succumb to their injuries before arrival to the hospital. Even though they have a higher fatality rate, penetrating cardiac injuries are relatively easy to diagnose and they have straightforward management protocols. On the other hand unexpected non-penetrating cardiac injuries, especially in haemodynamically stable patients, are not looked out for and can be difficult to diagnose. They may have a delayed presentation leading to poor patient outcomes.

Clinicians should have a high index of suspicion when wound paths are in the vicinity of the heart, to avoid missing early signs and possibly prevent late presentation of these injuries.

CASE PRESENTATION: Two previously well male patients aged 29 and 33 years old respectively, sustained gunshot wounds to the thoracoabdomen which in each case became associated with non perforating cardiac injuries. The first case highlighted the unfortunate end of these uncommon injuries when there are other serious injuries present. The second case illustrated possibility of late complications even after management of non-penetrating cardiac injury.

CLINICAL DISCUSSION: In these cases, shock wave injury refers to non penetrating cardiac injury induced by high a voltage bullet in proximity to the heart/pericardium. A thorough history and examination in addition to multiple investigational modalities should be performed in order to exclude cardiac shockwave injuries. In some instances serial imaging studies are needed to detect the earliest changes associated with these injuries.

CONCLUSION: Cardiac injuries carry a high morbidity and mortality and therefore a timeous diagnosis and management of these injuries is essential to prevent fatalities.

* Corresponding author at: Department of Surgery, Wits Medical School, 7 York Road, Parktown, Johannesburg, 2193, South Africa.
E-mail addresses: sisiludongwis@gmail.com (W. Ngwisanyi), Shirley.Moeng@wits.ac.za (S.F.A.P. Moeng), Maeyane.Moeng@wits.ac.za (M. Moeng).

1. Introduction

Cardiac injury is associated with significant mortality in patients with traumatic injuries [1]. Injuries to the heart can also be categorized as either penetrating cardiac injuries (PCI) or non-penetrating cardiac injuries [2]. Non-penetrating cardiac trauma can also be caused by blast injury with resultant shockwave injury to the heart. The evolving nature of the clinical scenario seen in these injuries may create a diagnostic challenge to the surgeon. A high index of suspicion is required to avoid poor outcomes [3,4].

The two cases presented were managed in an academic hospital and they highlight cardiac manifestations due to shockwave injury in patients presenting with gunshot wounds to the thoracoabdomen to emphasize:

- the importance of a high index of suspicion
- timely intervention in patients presenting with such injuries
- the diagnostic dilemma
- adverse outcomes of cardiac injury when associated with multiple other injuries.

2. Case one

A 29 years old, previously healthy male with no known chronic illnesses was admitted with gunshot wounds to the left thoracoabdomen. A physical examination revealed that he was fully conscious with a Glasgow coma score (GCS) of 15; normothermic; pulse of 170b/min; respiratory rate of 21/min; saturation of 96 % on room air, and blood pressure of 125/64 mmHg. He had bullet wounds on the left fifth intercostal space, on the midclavicular line and the posterior chest wall at the tip of the scapula (on the same side). His respiratory assessment revealed decreased air entry to the left side of the chest, and the cardiovascular examination revealed only remarkable tachycardia. His abdomen was soft and non-distended, with a stable pelvis. The rest of the clinical examination was unremarkable. His arterial blood gas showed respiratory acidosis with mild elevation of the lactate. He was intubated in...
the emergency department (ED) to manage his respiratory failure and resuscitated according to the Advanced Trauma Life Support (ATLS®) guidelines.

A chest x-ray confirmed a left haemothorax and an intercostal chest drain (ICD) was placed. A computed tomography (CT) of his chest and abdomen showed a left lung contusion, left haemothorax, and no haemopericardium was demonstrated. There was minimal free fluid seen on contrast CT scan of the abdomen.

A consultant (Attending) trauma surgeon and a consultant (Attending) general surgeon performed an exploratory laparotomy. Intraoperatively he was noted to have grade II liver, stomach and diaphragm injuries. Left-sided ICD drained over one litre of blood while in theatre, and a decision was made to perform left anterolateral thoracotomy. The pericardium was inspected from outside, and no obvious haemopericardium was noted. There was lung injury and a tractotomy and lung suturing was performed. The patient developed severe metabolic acidosis with the associated anaemia (a haemoglobin of 4.5 g/dL). He was transfused a total of six units of blood, three units of fresh frozen plasma and two mega units of platelets in addition to other fluids.

The patient was taken to the trauma intensive care unit (ICU) postoperatively, where he remained acidic with low blood pressures, tachycardic and hypothermic. The ICD and abdominal drains both drained minimal blood over the short stay in the ICU. The resuscitation phase was continued in the ICU; however, the patient demised within 24 h of admission into hospital and five hours post operation.

An autopsy confirmed chest injuries and chest interventions and revealed a previously unsuspected cardiac tamponade; not less than 300 mL of blood was extracted from an intact pericardial sac. The left ventricle showed a 3.5 cm long superficial injury to the epicardium. See Figs. 1–3.

3. Case two

Emergency medical services brought in a 33 years old previously healthy male patient with no known comorbidities to our emergency unit with a history of multiple gunshot wounds to the thoraco-abdomen. On arrival he was fully conscious with a Glasgow coma score (GCS) of 15, a blood pressure 138/77 mmHg, heart rate 71/min, respiratory 28/min, temperature 36.5°C and saturation 99% in room air. The airway was self-maintained, C-spine cleared. Air entry was equal bilaterally.

On examination, the patient had a left parasternal costochondral gunshot wound, a subclavian region gunshot wound and two more gunshot wounds to the abdomen. The abdomen was distended and tender. Emergency focused abdominal sonogram for trauma (FAST) confirmed free fluid in the abdomen and a pericardial effusion. The patient was then taken to radiology for a contrast pan–CT scan while the theatre was being prepared. (See Figs. 4 and 5) Laparotomy performed by consultant trauma surgeon and attending general surgeon showed multiple injuries to the small bowel (grade IV), descending colon (grade IV), Grade III liver and Grade III injury of the pancreas. The abnormal physiology and need for ongoing transfusions necessitated damage control surgery.

A pericardial window performed through the central tendon showed a grade II cardiac injury and a pericardial washout was done. No penetrating injury to the heart was seen. The patient was then taken to the intensive care unit (ICU) for continued resuscitation phase of Damage control surgery. The patient was brought back to theatre for a re-look laparotomy at forty-eight hours, where a distal pancreatectomy. Hartmann’s procedure, small bowel resection and anastomosis, and definitive stomach repair were performed. A closed suction drain was inserted in the peripancreatic region. He was then taken back to ICU, where he continued to improve. He was successfully extubated tolerated feeds very well. The pericardial drainage remained minimal and was successfully removed on the fourth day. The pancreatic closed suction drainage remained minimal.

The patient subsequently developed peri–pancreatic fluid on the fourteenth day, which was drained through a pigtail. An increased cardiothoracic ratio was noted on a chest x-ray, (See Fig. 6) and an echocardiogram showed a small pericardial effusion with a pericardial thickening. The patient was then treated for Dressler’s Syndrome with colchicine, and he responded well to this treatment. The patient’s overall condition improved until he was well enough to be discharged on day 35. He remained well on subsequent follow-up appointments, of monthly for the 1st three months, then 2 monthly for the next 12 months and then yearly, with normalised cardiothoracic ratio after a five day course of colchicine.
Fig. 4. Computed tomography showing pancreatic injury and minimal pericardial effusion on admission.

Fig. 5. Computed tomography showing pelvic and paracolic collection on admission.

Fig. 6. Chest x-ray Post Operation showing normal cardiothoracic ratio and cardiomegaly after the diagnosis of Dressler’s syndrome.

4. Discussion

The patient in our first case had a normal cardiovascular examination, except marked tachycardia. The CT scan of the thorax did not show any direct injury to the heart, and there was no evidence of pericardial fluid collection. This patient, however, had a fatal haemopericardium causing a cardiac tamponade that was only discovered at autopsy. The inspection of the pericardium in theatre,
without a pericardiomyotomy, may have resulted in missing the presence of a small haemopericardium. At autopsy, there was no direct visible injury to the pericardial sac but a long thin epicardial tear to the left ventricle with significant haemopericardium.

The ongoing coagulopathy resulted in persistent bleeding within the pericardial sac, which went on unnoticed. The associated multiple other competing injuries further delayed the diagnosis. This is likely because there was a delayed haemopericardium formation that was not present when the CT of the chest was performed. No cardiac enzymes were ever requested. ICU echocardiogram was not requested as more attention was placed on other existing injuries.

The patient described in the second case also had no direct penetrating injury to the heart; however, the ultrasound evaluation showed a pericardial effusion. Prompt suspicion and recognition of the cardiac injury allowed for a successful outcome. The GSW had not perforated the pericardium, but only a shock wave injury of the left ventricle was noted. This approach can only be done provided the injury is well inspected and noted to be stable. He recovered well but developed the uncommon complication post-pericardiomyotomy. This is usually seen in more extensive pericardiotomy cases. The pericarditis was successfully treated with colchicine.

Non-penetrating cardiac injuries (NPCIs) resulting from chest wall injury can follow an unpredictable course of clinical presentation ranging from mild symptoms to life-threatening physiologic changes or death [3]. The presence of injuries to other organ system compounds the difficulty in diagnosing these NPCs because of competing priorities where the attention and intervention are likely to be allocated to the more visible injuries to other areas than to the heart, especially if the initial assessment did not show evidence of cardiac injury. Additionally, in some haemodynamically stable patients with NPCs the cardiac manifestation of the injuries may present later, and this could potentially result in delayed intervention and in some cases, poor patient outcomes.

In haemodynamically stable patients with cardiac injuries, pericardial fluid collections can be managed with a pericardial window, an opening that is made in the pericardium for diagnosis or relief of a haemopericardium or cardiac tamponade. Nicol et al. reported positive outcomes associated with the use of this surgical procedure only in haemodynamically stable patients in whom bleeding had ceased [6]. Furthermore, it can result in post-pericardiomyotomy syndrome manifesting as clinical findings ranging from an uncomplicated pericarditis to a complicated pericarditis with a large pericardial effusion and cardiac tamponade in severe cases [7]. Opening a central tendon when performing a pericardial window, in the presence of abdominal injuries, can lead to contamination of the pericardium by bowel contents. Furthermore, tendons have poor blood supply leading to poor healing.

Ultrasound scan of the chest account for the most commonly employed investigational modality to assess the cardiac injury, but it has limitations. Additional tests such as central venous pressure measurement, chest x-ray, an electrocardiogram, and computed tomography of the chest have been suggested as useful modalities in the assessment of cardiac trauma [8,9]. Both our patients had penetrating high impact wounds to the chest that were complicated by shock wave injuries to the heart.

5. Conclusion

- Other competing injuries should not distract the clinician from recognizing these potentially fatal injuries.
- Clinicians should maintain a high index of suspicion for cardiac injuries when dealing with proximity GSW to the heart, despite early negative radiological findings.

The work has been reported in line with the SCARE 2020 criteria [10].

Declaration of Competing Interest

The authors report no declarations of interest.

Sources of funding

No Funding was sought for this publication.

Ethical approval

Ethics approval was given by: University of the Witwatersrand, Johannesburg. Human Research Ethics Committee (MEDICAL). Clearance Certificate No. M2011125.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

**WN:** Design, analysis and interpretation of data, drafting the article, final approval.

**SM:** Data collection, interpretation of data, critical revising, final approval of manuscript.

**MM:** Conception, Data interpretation, revision of manuscript critically for intellectual content, final write-up and final approval for submission.

Registration of research studies

Not applicable.

Guarantor

Maeyane Moeng.

Provenance and peer review

Not commissioned, externally peer-reviewed.

References

[1] H.V. Tran, M. Charles, R. Garrett, P. Kemper, C. Howard, Z. Khorgami, Ten-year trends in traumatic cardiac injury and outcomes: a trauma registry analysis, Ann. Thorac. Surg. (110) (2020).

[2] S.J. Warrington, K. Mahajan, Cardiac trauma. [Updated 2020 Jul 17], in: StatPearls [Internet], StatPearls Publishing, Treasure Island (FL), 2020, Available from: https://www.ncbi.nlm.nih.gov/books/NBK430725.

[3] J.C. Tyburski, L. Astra, R.F. Wilson, et al., Factors affecting prognosis with penetrating wounds of the heart, J. Trauma 48 (4) (2000) 587–590.

[4] S.A. Bellister, B.M. Dennis, O.D. Guillamondegui, Blunt and penetrating cardiac trauma, Surg. Clin. North Am. 97 (5) (2017) 1065–1076.

[5] S.B. Johnson, A.J. Liedtke, Nonpenetrating cardiac trauma, in: J.S. Alpert (Ed.), Cardiology for the Primary Care Physician, Current Medicine Group, 2001, http://dx.doi.org/10.1007/978-1-4615-6601-4_36.
[6] A.J. Nicol, P.H. Navsaria, M. Hommes, C.G. Ball, S. Edu, D. Kahn, Sternotomy or drainage for a hemopericardium after penetrating trauma: a randomized controlled trial, Ann. Surg. 259 (2014) 438–442.

[7] M. Imazio, B.D. Hoit, Post–cardiac injury syndromes. An emerging cause of pericardial diseases, Int. J. Cardiol. 168 (2) (2013) 648–652.

[8] N.C. Campbell, S.R. Thomson, D.J. Muckart, C.M. Mesmann, J. Van Middelkoop, J.B. Botha, Review of 1198 cases of penetrating cardiac trauma, Br. J. Surg. 84 (12) (1997) 1737–1740.

[9] G.P. Fraga, J.P. Espinola, M. Mantovani, Pericardial window used in the diagnosis of cardiac injury. Acta Cirúrgica Brasileira 23 (1) (2008) 208–209.

[10] R.A. Agha, T. Franchi, C. Sohrabi, G. Mathew, for the SCARE Group, The SCARE 2020 guideline: updating consensus Surgical Case REport (SCARE) guidelines, Int. J. Surg. 84 (2020) 226–230.