RADIOLOGY CASE REPORTS

AUTHOR INFORMATION PACK

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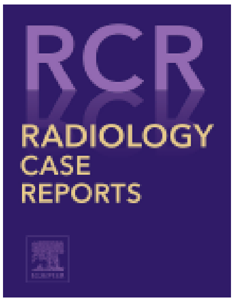

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Case Report

Traumatic atrial septal defect diagnosed by bedside point-of-care ultrasound☆,☆☆,★

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A R T I C L E I N F O

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MVA
Atrial septal defects
POCUS
Echocardiogram
FAST

A B S T R A C T

Atrial septal defects (ASD) caused by traumatic events, specifically blunt cardiac trauma, are considered an infrequent occurrence, yet their true prevalence has been difficult to ascertain. The general lack of knowledge is likely due to the pathology being severely understudied. We present the case of a 21-year-old male who was diagnosed with ASD following a motor vehicle accident. Initial assessment utilizing the point-of-care ultrasound (POCUS) technique - focused assessment with sonography for trauma (FAST) was found to be negative for free intraperitoneal or pericardial fluid. Subsequent computed tomography displayed multiple injuries but agreed with the FAST exam findings of no fluid within the abdomen or pericardium. Later in the patient's care a dedicated POCUS transthoracic echocardiogram was performed which identified right sided heart dilatation. The patient was managed in the intensive care unit (ICU) for an extensive period but recovered sufficiently to be discharged. The plan was to repair the ASD on a non-emergent basis. This case highlights the importance and diagnostic utility of bedside POCUS.

Categories: Emergency Medicine

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Introduction

Traumatic atrial septal defects (ASD) have generally been understudied, with many of the previously reported cases having occurred alongside ventricular septal defects (VSD) [1]. It has been proposed that blunt trauma may induce an atrial septal defect (ASD) through a few mechanisms [2]. Forces directed at the patient's abdomen may lead to increased intracardiac pressures [2]. Additionally, the heart may be compressed between the sternum and vertebral bodies, leading to chamber or septal rupture [2]. Acceleration and deceleration forces could potentially induce shearing forces which may lead to tearing of the septum or chamber walls [2]. Blunt trauma continues to be a prevalent occurrence, occasionally causing cardiac lesions and in these cases, prompt diagnosis can be directly linked to outcomes and overall survival [3]. Yet, rapid diagnosis of these cardiac injuries has often been delayed due to the technological limitations of bedside echocardiographic equipment [3]. Until relatively recently, ultrasound technology for use in the trauma bay lacked the capability to yield more than a pericardial glimpse clearly or precisely during a focused assessment with sonography for trauma (FAST) examination [4]. As both image quality and portability of bedside ultrasounds continues to improve, so does its ability to augment conventional assessment methods and positively impact patient care. In this case, a young man was diagnosed with a traumatic atrial septal cardiac lesion following involvement in a motor vehicle accident.

Case report

A 21-year-old male without known medical history presented to a level 2 trauma center after being involved in a motor vehicle accident (MVA). It was presumed that the patient had been unrestrained and was found a short distance away after being ejected from the vehicle. The vehicle sustained significant damage, including a broken windshield. Upon EMS arrival to the scene, the patient was hemodynamically stable with a Glasgow Coma Scale (GCS) score of 13 and complained of bilateral leg pain. In the trauma bay the patient was noted to have an open ankle fracture, abrasions to the thorax and extremities, but a negative FAST examination. After obtaining additional radiographic imaging the patient became unstable, was hypotensive, and was intubated due to decreased responsiveness. An inferior gluteal artery aneurysm was embolized. A Cardiology consultation was performed secondary to an elevated troponin value of 5.38 ng/ml (normal <0.05 ng/ml). An emergency medicine resident rotating on the Cardiology service performed the initial consult which included a dedicated POCUS transthoracic echocardiogram (see Fig. 1). This echocardiogram which included the apical four chamber, parasternal long, and parasternal short axis views identified severe right atrial (RA) and right ventricle (RV) enlargement with accompanying reduced free wall motion. These findings were confirmed by the consulting cardiologist and a second transthoracic echocardiogram performed within the echocardiography suite. Due to continued instability the patient was then taken for an exploratory laparotomy which yielded a liver laceration, as well as retroperitoneal and mesenteric hematomas. A transesophageal echocardiogram (TEE) study was performed in the operating room (see Fig. 2) and exposed an interatrial septal rupture with significant left-to-right shunting.

Over the next four days the patient was stabilized, yet serial echocardiography indicated a persistent atrial septal defect with freely mobile myocardium about the rim, measuring roughly 1.2 centimeters. This was consistent with the traumatic insult from his MVA. His right ventricle was dilated with trace tricuspid regurgitation and severely reduced systolic function. The patient's left sided systolic function was preserved. There was moderate dilation of the right atrium as well. For the duration of the patients' hospitalization, he had an oxygen saturation persistently in the mid-90s, despite aggressive pulmonary optimization. It was suspected that this was due to mixing of oxygenated and deoxygenated blood via the atrial septal defect. Due to the extensive degree of traumatic injury, the decision was made for conservative management of his cardiac lesion with an intent to repair the ASD percutaneously following discharge. The patient's hospital course was protracted, requiring 19 ICU days, and was complicated by progressive hypertension, thought to be in-part due to his evolving right-sided heart failure.

Despite his initial instability, he progressed to extubation and was eventually discharged to rehabilitation. The extent of disability due to the patient's cardiac injury is difficult to ascertain as his other injuries were significant and included a subdural hematoma, subarachnoid hemorrhage, diffuse axonal injury, sternal fracture with mediastinal hematoma and pneumatocele, multiple thoracolumbar fractures, pelvic fracture, trimalleolar fracture, and liver laceration.

Discussion

Data outlining traumatic atrial septal defects is sparse and centered about iatrogenic causes [5–7]. Of the cardiothoracic trauma related case studies that do exist, nearly all outline young individuals, such as ours, who were involved in high mechanism vehicle accidents. In our case, the ASD was felt to be post traumatic and not pre-existing given the magnitude of his trauma, his young age, the fact that he had no prior history of a heart murmur and his otherwise good cardiovascular health prior to the accident. Our patient had not had any prior echocardiograms to indicate otherwise.

Atrial septal injuries occur rarely in this setting and are most comprehensively detailed in retrospective autopsy studies [7–10]. One such study revealed 25 retrospective autopsy cases of atrial septum rupture, 8 of which outlined it as the sole cardiac lesion [7]. A brief period of survival (≤2 days) in only 5 of those 8 cases was noted [8], suggesting cardiothoracic trauma leading to ASD carries significant mortality.

ASD is primarily a congenital defect and can be thought of as a chronic or genetic condition, unlike acute or post traumatic ASD [11]. Most children with preexisting ASD have minimal symptoms if any are present [12]. Preexisting ASD occurs during the development of the heart, and the cause is

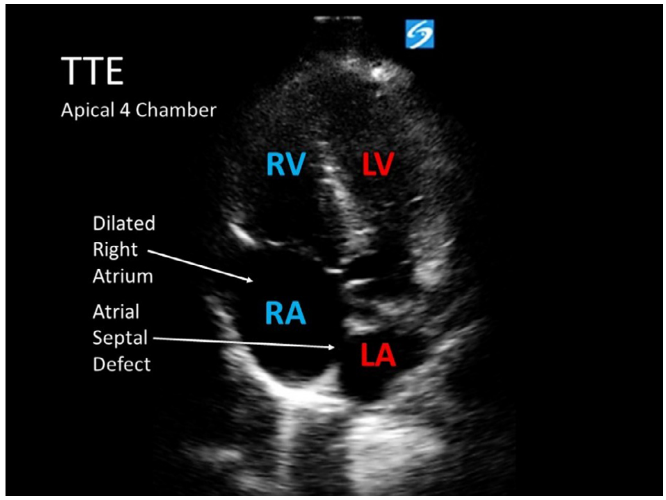

Fig. 1 – Transthoracic echocardiogram. Apical 4-chamber view, demonstrating a dilated right atrium with communication or atrial septal defect between the right and left atria. RV = Right ventricle, LV = Left ventricle, RA = Right atrium, LA = Left atrium.

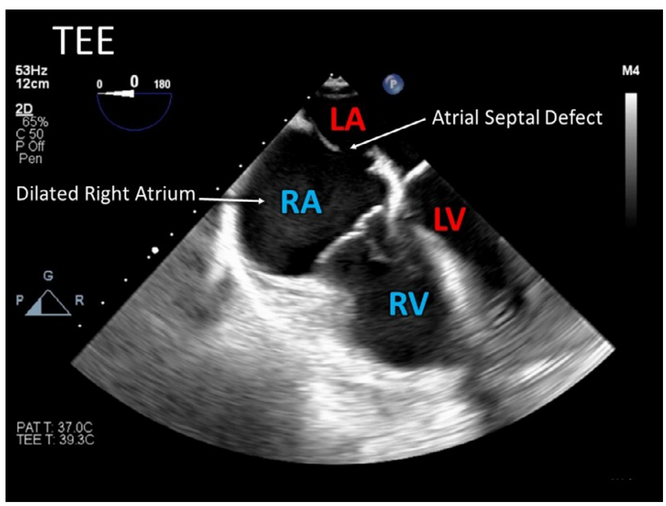

Fig. 2 – Transesophageal echocardiogram. Atrial septal defect is noted between the right and left atria. LA=Left atrium, RA=Right atrium, LV=Left ventricle, RV=Right ventricle.

unclear [11]. However, this defect is autosomal dominant and is recognized as due to gene mutations [11]. Alternatively, the premise behind traumatic atrial septal injury is an acute force against a variable intracardiac volume which induces enough pressure change to overcome the compliance of a particular myocardial structure [7]. It is postulated that the timing of extrinsic force with cardiac cycle phase, coupled with direction of chest compression are important variables with respect to the subsequent cardiac injury sustained [2,7,9,13,14]. The atria may be most vulnerable when they are maximally distended – namely with the ventricles in systole, the A-V valves closed, and the patient in deep inspiration with maximal venous return [11] (i.e., in an unexpected vehicle impact). Further, the atrial wall has some built-in anatomic weakness attributed to the fossa ovalis [7]. In contrast, ventricular septal ruptures are thought to occur when anterior-posterior cardiovascular compression is sustained during maximal ventricular hydraulic loading of late diastole/early systole [9,10,13,14].

The diagnosis of chronic versus acute ASD may vary. Children and adolescents are diagnosed due to an abnormal finding leading to an echocardiogram, electrocardiogram, and or chest radiogram [9]. Patients with a post traumatic ASD are typically diagnosed using POCUS or transesophageal echocardiogram (TEE) [15,16]. TEE is primarily used to evaluate the severity and location of the newly onset ASD. Delay in diagnosis of traumatic cardiac injury is a historically documented occurrence, particularly in identification of VSD (however the reasons can also be extrapolated to atrial septal lesions) as initial assessment is focused on resuscitation and easily identifiable concomitant injuries [7,10]. With the advancement of ultrasound technology – most notably the ability to rapidly evaluate at the bedside and diagnose at the point of care, this problem could be mitigated. Echocardiography provides a rapidly accessible method of obtaining immediately actionable data regarding hemodynamically significant cardiac trauma and could provide significant mortality benefit by decreasing time-to-treatment of life-threatening lesions. It is estimated that since 1988, 85% of the ventricular septal defect (VSD) cases in the literature have been diagnosed using echocardiography, outpacing traditional diagnosis by cardiac catheterization; the remainder were diagnosed postmortem [10]. In total, mortality resulting from severe cardiac injury is approximately 30%, and prognosis of more thoroughly studied traumatic VSDs is directly related to the size of the defect as well as concomitant injuries [10]. Mortality secondary to development of CHF also increases significantly in these patients when they are managed non-operatively (56% vs 10%) [10], making timely diagnosis of operative lesions essential to outcome.

Conclusion

Survival of traumatic atrial septal cardiac defects is rare. The ease and accessibility of bedside point-of-care ultrasound further supports its importance as a diagnostic modality in these cases. While typically the single window of the subxiphoid approach is performed during the POCUS FAST examination, continued hypotension or elevation of cardiac markers can be further evaluated with a dedicated POCUS transthoracic echocardiogram.

Patient consent

Written consent for the publication of this case report was obtained from the patient who has reviewed a copy of the manuscript.

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