


Case Report

Penetrating cardiac injury repaired under “intentional cardiac arrest” with adenosine triphosphate

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Background: Repairing a cardiac injury with beating heart is sometimes difficult and is associated with increased risks of complications. Here we report a case of cardiac injury repaired with administration of adenosine triphosphate (ATP).

Case Presentation: A 46-year-old man was stabbed in his chest with a knife and transferred to our hospital. He was hemodynamically unstable, and echocardiography showed pericardial effusion. Emergency thoracotomy revealed a full-thickness injury in the right ventricle next to the coronary artery. He went into cardiac arrest and was resuscitated with adrenaline administration. We tried to suture immediately, but it was difficult because of tachycardia. After administering 20 mg of ATP (80 mg in total over 15 min), bradycardia was induced that led to “intentional cardiac arrest” after which suturing was performed. He was discharged on the 13th day without complications.

Conclusion: Cases of penetrating cardiac injury repaired using ATP are rare. Administration of ATP may be a useful option while repairing cardiac injuries.

Key words: Adenosine triphosphate, cardiac rupture, thoracotomy, trauma

INTRODUCTION

PENETRATING CARDIAC INJURY is one of the most lethal emergencies, requiring immediate surgical intervention to save lives in almost all cases.^{1,2} Repairing or suturing a beating heart can be difficult, with the risk of damaging the myocardium with needles and not being able to perform ideal suture or repair. Here, we report a case of a penetrating cardiac injury that was repaired using adenosine triphosphate (ATP).

CASE REPORT

A 46-year-old man was stabbed in the left chest with a knife and was transferred by ambulance to the emergency department of our hospital after 49 min. On arrival,

his vital signs were as follows: blood pressure, 78/56 mmHg; heart rate, 130 beats/min; respiratory rate, 36 breaths/min; and Glasgow Coma Scale score, 14 (E4V4M6). A 2.5-cm skin wound was identified at the left midclavicular line above the nipple (Fig. 1). Focused assessment with sonography for trauma (FAST) revealed pleural effusion in the left thorax. A chest drain was inserted and more than 700 mL of blood was drained. After chest drainage, FAST demonstrated pericardial effusion without echocardiographic signs of cardiac tamponade. Because of the patient's unstable hemodynamic status, emergency Clamshell thoracotomy was started 23 min after arrival. A massive hemothorax in the left thorax, left lung posterior lobe injury, pericardial injury, and hemopericardium with blood clots were observed. A 10-mm defect was found in the right ventricle near the left anterior descending coronary artery (Fig. 2A). Fifteen minutes after thoracotomy, the patient went into cardiac arrest and recovered minutes after blood transfusion and intravenous adrenaline administration. After the return of spontaneous circulation, his heart rate was 160 beats/min and blood pressure was 160/80 mmHg. It was difficult to suture the defect directly because of a blood spurt from the injury site. Rapid intravenous administration of ATP (20 mg) was performed using a central

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Fig. 1. Injury site on arrival. A 2.5-cm wound was seen just above left nipple. The arrow shows the injury site.

venous catheter to induce chemical cardiac arrest. However, the chemical cardiac arrest was not induced after a single dose and ATP was infused repeatedly. After infusing four times (80 mg ATP), the patient's heart rate fell to under

20 beats/min and led to pulseless electrical activity in 15 s. We repaired the cardiac wall by using a horizontal mattress suture (Fig. 2B). Approximately 15–20 s after ATP administration, cardiac function resumed spontaneously. After inserting the chest and pericardial drains, we ended the procedure by closing the wound.

Although repeated echocardiographic check-ups showed a septal injury, no symptoms of heart failure were observed. On the 13th postoperative day, the patient was discharged without complications.

DISCUSSION

PENETRATING CARDIAC INJURY presents with shock due to either cardiac tamponade or massive hemorrhage.² Mortality is especially high in cases of complicated massive hemothorax.¹ Therefore, early diagnosis and management decisions are important. Control of bleeding and drainage of the hemopericardium are crucial; however, it is sometimes difficult to suture a beating heart.

ATP produces adenosine as a metabolite after administration, which strongly suppresses atrioventricular conduction and stops tachycardia.³ The use, safety, and efficacy of ATP have been reported during surgeries including thoracic endovascular aneurysm repair or clipping for cerebral aneurysm in subarachnoid hemorrhage, where it affects the cardiac beating motion to temporarily induce cardiac arrest.^{4,5} Stigall *et al.*⁶ reported that the use of adenosine–lidocaine–magnesium decreases the amount of bleeding in an animal study.

Six cardiac injury cases that were repaired using adenosine have been reported (Table 1).^{7–10} In each report, adenosine was rapidly administered intravenously at a dose of

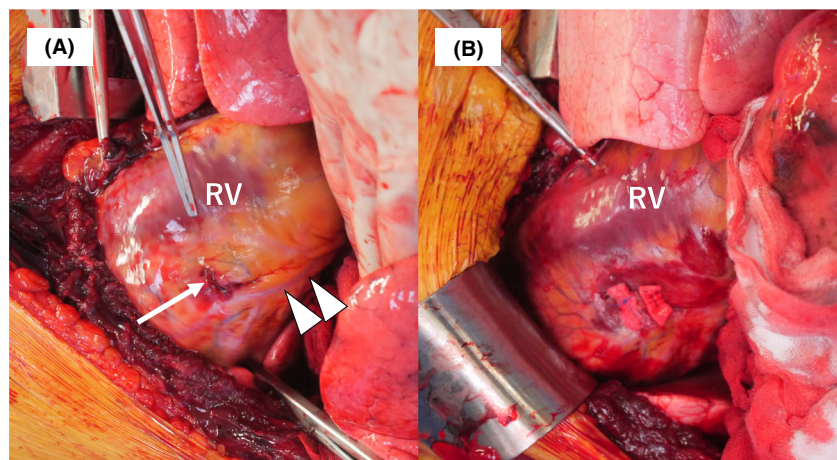


Fig. 2. Operative findings. Injury was seen near the left anterior descending coronary artery. (A) before repairing and (B) after repairing. The arrow shows the injury site and the arrowhead the left anterior descending coronary artery. RV, right ventricle.

Table 1. Cardiac injury repaired with adenosine administration

Case, age (years)/sex	Mechanism of injury	Injury site	Adenosine (mg)	Approach of thoracotomy	Operative procedure	Complications
22/Male	Stab wound	Right ventricle	3	Median sternotomy	Suturing	None
24/Male	Stab wound	Pulmonary artery	3	Median sternotomy	Suturing	None
48/Male	Stab wound	Apex	3	Median sternotomy	Suturing	None
18/Male	Stab wound	Left ventricle	3	Median sternotomy	Suturing	None
29/Male	Stab wound	Left ventricle	12	Anterolateral thoracotomy	Suturing	None
29/Male	Stab wound	Left ventricle, left anterior descending artery	12	Median sternotomy	Suturing	None
46/Male	Stab wound	Right ventricle	80 [†]	Clamshell thoracotomy	Suturing	None

[†]Adenosine triphosphate.

3–12 mg, and within 30 s of administration, the heartbeat stopped for a few to 40 s. The heartbeat resumed automatically in all cases, and there was no need for drug administration or pacing.

To the best of our knowledge, this is the first penetrating cardiac injury case in Japan that was repaired with ATP administration for controlling the heart rate. Although it is not possible to make a simple comparison of the doses of ATP and adenosine, ATP is required approximately two to three times as much as adenosine.³ In this case, cardiac arrest was achieved in approximately 15 s after ATP administration and the normal heartbeat was resumed without pacing or drug administration.

The patient had a strong heart rate (160 beats/min) before the repair, and accurate suturing was needed because the injury site was near the left anterior descending artery. It was possible to repair without complications by achieving the cessation of pulsation within a few seconds of observing active bleeding.

CONCLUSION

WE REPORT A case of acute cardiac injury in which the heart rate was controlled by ATP administration. ATP administration may be useful for injured areas where collateral damage is a concern or for cardiac injuries that are difficult to repair due to tachycardic pulsation.

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DISCLOSURE

Approval of the research protocol: N/A.

Informed Consent: Informed consent was obtained from the patient.

Registry and the Registration No. of the study/trial: N/A.

Animal Studies: N/A.

Conflict of interest: None declared.

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