

Anesthetic Management for Chest Tube Removal from the Right Atrium by Interventional Radiology: A Case Report

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Abstract

Procedural complications are not uncommon in a hospital setting, and additional interventions are often warranted in order to mitigate any collateral injury. This report details the case of a 48-year-old male who experienced a pneumothorax immediately after central line placement, requiring a chest tube for lung reexpansion. During initial placement, the small-bore chest tube was advanced transhepatically into the hepatic vein, coursing through the inferior vena cava (IVC) and terminating in the right atrium. Removal was performed by interventional radiology under anesthesia uneventfully, although extensive planning went into the anesthetic management for the procedure.

Keywords: epididymal cyst; transillumination; management

Glossary of Terms:

IVs – peripheral intravenous catheters

PRBCs – packed red blood cells

ICU – intensive care unit

CT – computed tomography

IVC - inferior vena cava

TTE – transthoracic echocardiography

ECMO - extracorporeal membrane oxygenation

RIC – Rapid infusion catheter

Introduction

Placing a central line is a commonly performed procedure in the inpatient setting, and while placement is a relatively safe procedure, it is not without risk. Cardiac, pulmonary, and vascular injury can occur, but since the advent of ultrasound immediate sequelae are seen much more infrequently, with incidence rates as low as 4%.¹ Regardless of technique, one of the most commonly occurring complications is the development of a pneumothorax. This results from injury to the parietal pleura during needle insertion or with dilatation utilizing the Seldinger technique, and is thought to occur in 1% of all central line placements.^[1] Factors that increase the likelihood of causing a pneumothorax include subclavian attempt, the use of a larger-bore needle or catheter, and multiple attempts at gaining access.^[1] This can be managed conservatively if the size of the pneumothorax is relatively small with supplemental oxygen and observation.^[1] However, a larger pneumothorax or a tension pneumothorax that leads to hemodynamic instability generally requires decompression with the placement of a chest tube.

Chest tube placement can be a lifesaving intervention in a patient requiring urgent decompression. However, this procedure also carries

with it an inherent risk. Currently, the known complication rate for chest tube placement is thought to be within 5 to 10%.² Of these, the most commonly encountered complications are chest tube malposition and injury to the surrounding anatomical structures. The lungs, diaphragm, and vasculature are amongst the most commonly traumatized. Hepatic injury is rarely reported during chest tube placement; however, when seen, it is usually heralded by severe hemodynamic changes.^[2]

Herein we describe the case of a 48-year-old male who underwent a central line placement in order to administer vasopressors after a cardiac arrest. This initial procedure was complicated by a pneumothorax requiring the insertion of a chest tube, which was erroneously placed transhepatically into the inferior vena cava (IVC) and terminating in the right atrium. We describe the events surrounding the placement of this chest tube, its removal, and the anesthetic considerations throughout. This manuscript adheres to the applicable EQUATOR guideline. Consent was obtained by the patient's healthcare proxy for the submission of this report.

Case Description:

The patient was a 48-year-old male with a past medical history of alcohol abuse, hypertension, diabetes, and attention-deficit/hyperactivity disorder who was found unresponsive by his mother in their home. Per the instructions of the emergency medical services, the mother began chest compressions for 15 minutes until the arrival of the paramedics. After an initial assessment, they found that the patient was in asystolic arrest and performed advanced cardiac life support for an additional 15 minutes. During this time, the patient was intubated with an 8.0 mm endotracheal tube atraumatically. After 15 minutes return of spontaneous circulation was achieved and the patient was transported to the hospital.

Upon transfer to the hospital, two 18-gauge peripheral intravenous catheters (IVs) were placed in the right and left forearms. The patient was found to be hypotensive and was given two liters of crystalloid, two units of packed red blood cells (PRBCs), and was started on norepinephrine and phenylephrine infusions. In the emergency department, prior to being admitted to the intensive care unit (ICU), a central line was placed in the right internal jugular vein by Seldinger technique. Correct needle placement was confirmed using ultrasound; however, subcutaneous crepitus was noted at the insertion site shortly after placement. A post-procedural x-ray confirmed a significant right-sided pneumothorax and the emergency room team quickly placed a right-sided small-bore chest tube for decompression. A post-procedural x-ray showed that lung reexpansion was unsuccessful, and a second small-bore chest tube was placed successfully.

In route to the ICU, the patient underwent a computed tomography (CT) scan of the abdomen and chest, which showed that the initial small-bore chest tube was placed transhepatically into the inferior vena cava and terminated in the right atrium.

Transthoracic echocardiography (TTE) was performed in the ICU which confirmed right atrial placement. Shortly thereafter, a right femoral triple lumen catheter and a right femoral arterial line were placed by the critical care team. The cardiothoracic surgery service, the general surgery service, and the interventional radiology service were consulted about management. The TTE and CT of the abdomen and chest showed no signs of perforation of the intrathoracic structures; therefore, cardiothoracic surgery deferred management. Interventional radiology believed that retrieval under fluoroscopy was most likely the safest option, and the anesthesiology team was consulted at that time for assistance with management.

In coordination with general surgery, the anesthesia service prepared an operating room to be ready on standby with a general surgery team present. The anesthesia team also coordinated with cardiothoracic surgery to have extracorporeal membrane oxygenation (ECMO) and a perfusionist on standby. The patient was taken to the interventional radiology suite intubated and sedated. Prior to the procedure, a seven French rapid infusion catheter (RIC) was placed in the right wrist and connected directly to a rapid infuser. Four units of PRBCs, four units of fresh frozen plasma, and one unit of platelets were immediately available in the interventional radiology suite. Defibrillator pads were transferred with the patient from the ICU and a portable defibrillator was present in the procedure area. Norepinephrine and epinephrine infusions were attached to the femoral triple lumen catheter. Patient was maintained on 1.0% to 1.5% sevoflurane throughout the intervention.

During the procedure, contrast given through the chest tube confirmed placement in the right atrium. Under fluoroscopic supervision, the catheter was withdrawn into the IVC. During withdrawal, patient had four beats of monomorphic ventricular tachycardia which resolved spontaneously. The patient also became acutely hypotensive with a systolic blood pressure to 88 mmHg. He was bolused eight mcg of norepinephrine and started on a two mcg · min⁻¹

norepinephrine infusion at that time, which quickly corrected the patient's hypotension.

Shortly thereafter, the interventional radiology team withdrew the chest tube into the liver, where they performed a glue embolization during

withdrawal uneventfully. At the end of the procedure, total operative time was one hour and 13 minutes. The patient received 500 ml of lactated ringers, and estimated blood loss was 100 ml. The patient only required vasopressor support for 15 minutes during chest tube withdrawal from the right atrium. He was brought back to the surgical ICU intubated and without incident.

Discussion:

Transhepatic placement is a known but rare complication of chest tube insertion, and removal utilizing a glue embolization technique can be performed to mitigate hemorrhage.^{3,4,5} The occurrence of chest tube placement into the right atrium however, is exceedingly rare. Through an extensive literature search, we have only come across two other case reports of successful chest tube removal from the right heart, which were reported by Hamanaka et al. in 2018 and in a subsequent letter to the editor in response to the event.^{6,7} In both reports, a malpositioned chest tube entered the hepatic vein and terminated in the right ventricle, leading to severe blood loss or hemodynamic instability shortly after placement. Our patient remained relatively hemodynamically stable, providing ample time to devise an appropriate anesthetic plan to allow the patient to undergo the chest tube removal safely.

Our biggest concern was the potential for direct cardiac trauma, as the walls of the right atrium are relatively fragile and injury could lead to cardiac tamponade or arrest. Fortunately, we had ample time to coordinate with the cardiothoracic team, and ECMO support was on standby during the entire procedure. We also had central venous access in the event of overt visceral trauma requiring immediate bypass.

After withdrawal of the catheter into the liver our primary concern became the potential for hemorrhage. In terms of vascular access, we were relatively fortunate that the patient had two 18-gauge peripheral IVs, a femoral triple lumen catheter, and a femoral arterial line. However, if bleeding became severe, we felt a rapid infusion catheter was more appropriate, and a rapid infuser with ample blood products was immediately available. Additionally, we were able to coordinate with the general surgery team to have a fully equipped operating room on standby in the event that the interventional radiology team was not able to remove the chest tube safely.

The other intraoperative event we were concerned about was the development of malignant arrhythmias. Removing a small-bore chest tube from the right atrium in a patient who had recently experienced a cardiac arrest carried a high risk. We felt the placement of defibrillator pads preprocedurally was vital. At the end of the case, the patient only experienced a brief episode of monomorphic ventricular tachycardia, which resolved after five beats and did not require cardioversion.

This case reports signals the third case report of chest tube removal from the right heart after traumatic chest tube placement of which we are aware. However, this is the first account from an anesthetic perspective, which required careful planning and coordination to ensure that the patient could get through the procedure safely.

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