Hemothorax as an Occult Cause of Hypotension After Transseptal Puncture

Arthur Iturriagagoitia
Xavier Iturriagagoitia

Corresponding Author: Arthur Iturriagagoitia, e-mail: arthur_iturri@hotmail.com

Financial support: None declared
Conflict of interest: None declared

Patient: Male, 76-year-old
Final Diagnosis: Hemothorax
Symptoms: Hypotension
Medication: —
Clinical Procedure: —
Specialty: Cardiology • Critical Care Medicine

Objective: Unusual clinical course
Background: Catheter ablation is an increasingly used treatment modality for arrhythmias. Periprocedural complications have a low incidence but can be life-threatening. Therefore, knowledge of possible risks during the intervention and early recognition improve patient outcomes. Transseptal puncture from the right atrium is needed for left atrial access. This procedure is a critical step that can be complicated by penetrating cardiac injury.

Case Report: A 76-year-old patient with previous mitral valve port-access surgery underwent catheter ablation for atrial tachycardia. He developed hypotension following a challenging transseptal puncture, but transesophageal echocardiography did not demonstrate any pericardial fluid. After completing the procedure and arriving at the coronary care unit, the patient was found to be in hemorrhagic shock. CT angiography demonstrated a massive right hemothorax without active bleeding. More than 2.5 liters of blood was evacuated by chest drainage. Despite this serious complication, the patient made a full recovery without need for surgical exploration.

Conclusions: Hypotension during or shortly after catheter ablation should alert the physician to possible anaphylaxis, hemorrhage, or air embolism. Most patients develop bleeding near the access site or within the pericardial cavity with subsequent tamponade. This case illustrates that hemothorax due to pericardial laceration should be included in the differential diagnosis. Pleural fluid is visible on echocardiography and fluoroscopy during the procedure. Bedside lung ultrasound saves time in detecting a large hemothorax compared to CT scan. Efforts to optimize the safety of transseptal puncture remain important. Radiofrequency transseptal needles and intracardiac echocardiography are helpful tools in patients with difficult atrial septal anatomy.

Keywords: Catheter Ablation • Heart Atria • Heart Rupture • Hemothorax • Pulmonary Veins

Full-text PDF: https://www.amjcaserep.com/abstract/index/idArt/936188

1 Department of Cardiology, OLV Hospital Aalst, Aalst, Belgium
2 Department of Anesthesiology, Ghent University Hospital, Ghent, Belgium
**Background**

Transseptal puncture creates a passage from the right atrium to the left through the fossa ovalis. Gaining access to the left atrium is required for ablation of left-sided arrhythmias and for certain structural heart interventions. This technique relies on intracardiac or transesophageal echocardiographic (TEE) guidance to visualize the interatrial septum and ideal puncture location. Although generally safe in experienced hands, inadequate puncture can result in life-threatening situations such as tamponade due to cardiac perforation.

**Case Report**

We report the case of a 76-year-old male patient with no known allergies. He had a previous medical history of coronary heart disease treated with 3 stents in the left anterior descending artery. He also had severe mitral valve prolapse with a dilated left atrium and atrial fibrillation treated with port-access mitral annuloplasty and surgical cryo-ablation in 2011. He developed symptomatic atrial tachycardia despite medical therapy and was scheduled for catheter ablation. The procedure was performed under general anesthesia. Vascular access was obtained through the right femoral vein. The electrophysiologist used 2 transseptal sheaths (Swaitz Braided transseptal guiding introducer SLO, St. Jude Medical, 8.0 and 8.5 French, 63 cm length) and a HeartSpan transseptal needle (Biosense Webster, 18 Gauge, 71 cm length). Double transseptal puncture was performed under fluoroscopic and TEE guidance. **Figure 1** shows tenting of the posterior portion of the interatrial septum. There was no aneurysm or lipomatous hypertrophy of the septum. Gaining access to the left atrium was difficult and required more than 1 attempt. The patient’s blood pressure decreased to 70/40 mmHg about 1 minute after the puncture, but TEE did not demonstrate any pericardial fluid. The patient received intravenous fluids and intermittent phenylephrine and was started on low-dose norepinephrine. The hypotension was attributed to anesthetic drugs and the procedure was not aborted. The tachycardia was determined to be a mitral isthmus-dependent atrial flutter with a cycle length of 230 ms. The pulmonary veins were adequately isolated from previous surgery. The atrial flutter was slowed to a cycle length of 300 ms by creating several endocardial mitral isthmus linear lesions and epicardial lesions from the coronary sinus using a radiofrequency ablation catheter. However, a transmural block could not be achieved and the procedure was not prolonged any further because of ongoing hypotension.

Upon arrival at the coronary care unit, the patient was awake and did not report any pain, but was concerned because of the medical attention. Clinical examination showed pale lips and conjunctivae. The groin did not show any hematoma. Heart auscultation was normal, but there was decreased breath sound on the right side. The jugular veins were not distended. His heart rate was 90/min and he was in sinus rhythm. Blood pressure was 80/50 mmHg despite having received 3 liters of crystalloid fluid in the electrophysiology room. He had cold extremities and clammy skin, but no fever. He required 4 liters of oxygen, but was breathing comfortably. There was no skin rash or wheezing. Arterial blood gas showed a hemoglobin concentration of 9 g/dL, down from 13.7 g/dL before the procedure. Lactate was increased threefold above normal value. Bedside transthoracic echocardiography did not reveal any pericardial fluid. Fluid administration and norepinephrine dose were increased, blood was ordered, and an urgent CT angiography was requested because of concern for hemorrhagic shock. The scan showed a massive hemothorax on the right side, with a density indicating recent blood loss. There was no contrast blush, meaning absence of active bleeding. Blood was noted in the paracardial fat on the right side against the right inferior pulmonary vein (**Figure 2**). The hemothorax was managed with chest tube drainage, evacuating more than 2 liters of blood in the first 24 hours. Two units of packed cells were given. He had received protamine sulfate at the end of the procedure and did not require any more correction of coagulopathy. The patient was quickly weaned off vasopressor drugs. He did not require thoracoscopic debridement of pleural blood. Review of the fluoroscopic and echocardiographic images made in the electrophysiology room revealed an incorrect position of the transseptal sheath near the right pulmonary veins (**Figure 3**). On follow-up echocardiography, a small amount of pericardial fluid became evident. After 4 days, the chest drain was removed.
proved safety was not confirmed in 2 prospective trials, but lower incidence of tamponade with the RF needle. This im
needle in 1550 ablations for atrial fibrillation and reported a septum. Winkle et al compared standard needles with the RF needle instead of a conventional needle can be helpful in pa
septal puncture. Using a radiofrequency (RF) transseptal needle can theoretically be caused by 2 mechanisms: intrapleural rupture a pulmonary vein or left atrial rupture with pericardial laceration. We will discuss both possible causes.

Figure 2. CT angiography. CT demonstrates massive pleural effusion on the right side (red asterisk), the right inferior pulmonary vein (blue arrow), and the left atrium (purple asterisk). Note absence of contrast blush, but presence of blood against the posterior side of the right inferior pulmonary vein and of the left atrium.

Figure 3. Fluoroscopic projection with left atrial angiogram after transseptal puncture. Note the proximity of the pigtail catheter to the right pulmonary veins.

Discussion

Previous port-access surgery in our patient may have distorted the anatomy and rendered the transseptal puncture more challenging. Difficulty in the transseptal puncture may also be attributable to scoliosis, as seen on the patient’s CT scan. Several tools are available to facilitate a complex transseptal puncture. Using a radiofrequency (RF) transseptal needle instead of a conventional needle can be helpful in patients with anatomic variants such as a thickened interatrial septum. Winkle et al compared standard needles with the RF needle in 1550 ablations for atrial fibrillation and reported a lower incidence of tamponade with the RF needle. This improved safety was not confirmed in 2 prospective trials, but those included fewer patients [2,3]. Intracardiac echocardiography offers several benefits over TEE and aids in early detection of damage to intracardiac structures such as left atrial trauma following transseptal puncture [4]. Despite its advantages, we do not routinely use ICE because of limited experience and higher cost.

Hemodynamic deterioration shortly after transseptal puncture is usually caused by cardiac perforation leading to hemopericardium and tamponade. This can be recognized as periprocedural hypotension with the echocardiographic appearance of new pericardial fluid. Here bleeding was not identified during the intervention because of the absence of pericardial fluid. Transseptal access to the left atrium was complicated by a right hemotorax without hemipericardium. Abnormal pleural fluid was not identified during the intervention, but could have been detected with TEE and fluoroscopy. Lung ultrasound on the CCU was not performed. This bedside examination would have saved valuable time in establishing the diagnosis, avoiding the transport of an unstable patient to the CT scanner. Hemothorax is a collection of blood within the pleural cavity. The most frequent causes are traumatic and iatrogenic injury to the great vessels. Hemothorax is a rare complication of catheter ablation that is usually caused by laceration of the jugular or subclavian vein during cannulation [5]. The origin of bleeding in our patient could not be established with certainty because there was no contrast blush on CT and surgical exploration was not performed. Nonetheless, hemothorax without appreciable pericardial fluid in the setting of a difficult transseptal puncture can theoretically be caused by 2 mechanisms: intrapleural rupture a pulmonary vein or left atrial rupture with pericardial laceration. We will discuss both possible causes.

A short segment of each pulmonary vein near the veno-atrial junction is surrounded by a pericardial recess. Perforation at that level will lead to accumulation of blood inside the pericardial space. Damage to the extrapericardial part of a pulmonary vein can cause hemothorax, pulmonary hemorrhage, or hemoptysis, depending on whether the vein is perforated into the pleura, the lung, or a bronchus. The right inferior pulmonary vein has the shortest intrapericardial segment, ranging from 4.5 to 11 mm [6]. This explains why damage to this pulmonary vein is relatively less likely to result in hemopericardium. Traumatic injury to the pulmonary veins usually results from blunt chest trauma, particularly motor vehicle injuries [7]. With the increasing use of catheter-based cardiac interventions, iatrogenic pulmonary vein damage is emerging as an important consideration. Pulmonary vein injury during ablation procedures has been reported to cause pulmonary hemorrhage [8], hemoptysis secondary to rupture into a bronchus with bronchial-pulmonary venous fistula [9], and left atrial intramural hematoma [10]. The cause of pulmonary vein hemorrhage can be direct thermal injury in cryoballoon-based
techniques or mechanical injury due to stiff catheter equipment. Pulmonary vein laceration leading to hemothorax after transseptal puncture in ablation procedures has not yet been described. Because the right inferior pulmonary vein has the longest intrapleural course, and based on the inappropriate position of the transseptal sheath near the right pulmonary veins, the source of our patient’s hemothorax may have been the right inferior pulmonary vein. However, the odds of perforating a pulmonary vein during transseptal puncture are very low, and we therefore think that cardiac rupture with pericardial laceration is a more likely explanation.

Cardiac rupture in both blunt and penetrating trauma can lead to either tamponade or hemothorax depending on whether the pericardium is pierced. If the pericardial laceration is sufficiently extensive, it allows the blood to exit the pericardial compartment and drain into the mediastinum and pleura. Chest surgeons routinely examine the heart and pericardium when performing exploration for a massive hemothorax. However, many physicians do not expect a cardiac rupture when evaluating traumatic hemothorax, especially in the setting of iatrogenic penetrating cardiac injury. There are several case reports of delayed diagnosis of cardiac rupture due to absence of a large amount of pericardial fluid [11,12]. Nakano et al reported a case of right hemothorax due to perforation of the posterior wall of the left atrium diagnosed after finishing catheter ablation [13]. Because the left atrium has a much larger surface than a pulmonary vein, it is statistically much more likely that our patient’s hemothorax was caused by left atrial posterior wall perforation and associated pericardial tear rather than pulmonary vein perforation. The dilated left atrium and the appearance of a small amount of pericardial fluid on follow-up echocardiography support this hypothesis.

Conclusions

We report a second case of delayed diagnosis of hemothorax after transseptal puncture for catheter ablation. Clinical suspicion for hemothorax should be high if the patient becomes hypotensive after transseptal puncture, even in the absence of pericardial fluid. Periprocedural echocardiography and fluoroscopy can detect pericardial as well as pleural fluid. Ultrasound detection of pleural, pericardial, and abdominal bleeding is much faster than CT scan and should be part of the first-line assessment for patients who are unstable after a cardiac intervention.

Declaration of Figures’ Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

References:

1. Winkle RA, Mead RH, Engel G, Pattawala RA. The use of a radiofrequency needle improves the safety and efficacy of transseptal puncture for atrial fibrillation ablation. Heart Rhythm. 2011;8(9):1411-15
2. Hsu JC, Badhwar N, Gerstenfeld EP, et al. Randomized trial of conventional transseptal needle versus radiofrequency energy needle puncture for left atrial access (the TRAVERSE-LA study). J Am Heart Assoc. 2013 Sep;2(5):e000428
3. Fromentt S, Sarrazin JF, Champagne J, et al. Prospective comparison between conventional transseptal puncture and transseptal needle puncture with radiofrequency energy. J Interv Card Electrophysiol. 2011;31(3):237-42
4. Ren JF, Marchlinski FE. Monitoring and early diagnosis of procedural complications. Ren JF, Marchlinski FE, Callans DJ, Schwartzman D. In: Practical intracardiac echocardiography in electrophysiology. Malden, Massachusetts: Blackwell; 2006;180-207
5. Aldhooon B, Wichterle D, Peichl P, et al. Complications of catheter ablation for atrial fibrillation in a high-volume centre with the use of intracardiac echocardiography. Europace. 2013;15(2):24-32
6. D’Avila A, ScanaVaccio M, Sosa E, et al. Pericardial anatomy for the intervention-  
tional electrophysiologist. J Cardiovasc Electrophysiol. 2003;14(4):422-30
7. Le Guyader A, Bertin F, Laskar M, Cornu E. Blunt chest trauma: A right pulmo- 
nary vein rupture. Eur J Cardiothorac Surg. 2001;20(5):1054-56
8. Martí-Almor J, Jauregui-Abularach ME, Benito B, et al. Pulmonary hemorrhage after cryoablation ablation for pulmonary vein isolation in the treat- 
ment of atrial fibrillation. Chest. 2014;145(1):156-57
9. Fukunaga H, Higuchi R, Tanizaki K, Isobe M. Pulmonary vein perforation into bronchi: A rare but life-threatening complication of cryoballoon abla- 
tion Eur Heart J Case Rep. 2019;3(1):ytz022
10. Echahidi N, Philippin F, O’Hara G, Champagne J. Life-threatening left atrial wall hematoma secondary to a pulmonary vein laceration: An unusu- 
al complication of catheter ablation for atrial fibrillation. J Cardiovasc  
Electrophysiol. 2008;19(5):556-58
11. Ozumi H, Suzuki K, Hoshino H, et al. A case report: Hemothorax caused by rupture of the left atrial appendage. Surg Case Rep. 2016;2(1):142
12. Baker L, Almadani A, Ball CG. False negative pericardial Focused Assessment with Sonography for Trauma examination following cardiac rupture from blunt thoracic trauma: A case report. J Med Case Rep. 2015;9(35)
13. Nakano T, Hirata A, Sotomi Y, Higuchi Y. Right hemothorax caused by se- 
tal puncture during catheter ablation for atrial fibrillation: A case with atrial sepal aneurysm and pulmonary embolism. JACC Clin Electrophysiol.  
2018;4(4):555-56