Case Report
Emergency management of catheter-induced cardiac tamponade in patients with atrial arrhythmia

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Abstract: Cardiac tamponade remains the potentially life-threatening complication associated with catheter ablation. Thus, early recognition and rapid appropriate treatment of cardiac tamponade are mandatory to prevent the irreversible deterioration in perfusion of the brain and other important organs. In this study, three cases of catheter-induced cardiac tamponade in atrial arrhythmia patients were reported. Among them, case 1 refers to a patient with atrial tachycardia, who developed a small amount of pericardial effusion before leaving the catheter room, as confirmed by transthoracic echocardiography. No pericardiocentesis was performed since the vital signs of this patient were stable. Case 2 was a patient with symptomatic paroxysmal atrial fibrillation (AF), who developed pericardial effusion when the ablation catheter was withdrawn to the right atrium, as displayed on chest radiography, and subxiphoid Seldinger puncture was performed. Normal sinus rhythm and stable hemodynamic status were achieved one and a half hours later. Case 3 was a patient with symptomatic paroxysmal AF and a right-sided accessory pathway. Typically, the cardiac tamponade was induced by misdirected transseptal puncture, which was managed with pericardial drainage and surgical repair. Meanwhile, epicardial AF ablation and left atrial appendage (LAA) amputation were also performed in case 3. These cases have illustrated that the cardiac tamponade remains the most common potentially life-threatening complication associated with atrial arrhythmia ablation. On this account, it is important to maintain the sheath at the puncture site until surgical repair can be performed. Moreover, epicardial AF ablation and LAA amputation are alternative during surgical repair.

Keywords: Cardiac tamponade, atrial arrhythmia, catheter ablation, cardiac surgery, left atrial appendage

Introduction

Patients with atrial arrhythmia may develop uncomfortable symptoms as a consequence of tachycardia, and they are at risks of stroke, tachycardia-induced cardiomyopathy and medical treatment-related complications. Therefore, increasing attention has been paid to the development of interventional treatments for atrial arrhythmia. Catheter ablation is preferred to surgical ablation in most cases; however, the latter is favored if catheter ablation is unlikely to succeed or is not feasible. Notably, catheter ablation of atrial arrhythmia is one of the most complex interventional electrophysiological procedures [1]. Cardiac tamponade remains the most common potentially life-threatening complication associated with atrial arrhythmia ablation [2]. Therefore, the early recognition and rapid appropriate treatment of cardiac tamponade are necessary to prevent the irreversible deterioration in perfusion of the brain and other vital organs. In rare cases, percutaneous drainage may be inadequate and surgical repair is thereby necessary [3]. Unfortunately, there are few studies on conservative treatment, pericardial puncture and surgical repair at the same time. In this study, according to the changes of the vital signs, different treatment strategies were adopted. On the other hand, increasing number of epicardial-endocardial ablation procedures and surgical treatment for left atrial appendage (LAA) have been carried out over the past few years [4, 5]. However, to our best knowledge, there has been no report of surgical repair combined with epicardial pulmonary vein ablation and LAA amputation.

Case 1

A 72-year-old man with an eight-year-history of coronary heart disease was referred for abla-
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tion of the symptomatic and drug-refractory atrial tachycardia lasting for 1 year. Trans-thoracic echocardiogram revealed normal left ventricular systolic function, severe biatrial enlargement, with the left atrium being measured as 55 mm, and no intracardiac thrombus. Standard 12-lead electrocardiography (ECG) indicated an atrial tachycardia with an isoelectric interval and 2:1 to 4:1 of atrioventricular conduction (Figure 1A). A duodecapolar catheter was then placed in the coronary sinus, and atrial activation was the earliest in the proximal poles with activation proceeding distally. The cycle length of the atrial tachyarrhythmia was 252 ms with no variability of the cycle length. Meanwhile, that in the right atrium was 112 ms, and there was no evidence of an atrial tachycardia with a focal mechanism (Figure 1B), suggesting that the right atrium was not a part of the reentrant circuit. Moreover, electro-

Figure 1. An ECG and biatrial electroannatomical map. A. Standard 12-lead ECG revealed an atrial tachycardia with an isoelectric interval and 2:1 to 4:1 of atrioventricular conduction. B. The electroannatomical mapping showed that the cycle length in the right atrium was 112 ms, with no evidence of an atrial tachycardia with a focal mechanism. C. Activation around the mitral annulus was in a counterclockwise direction and entrainment manoeuvres proved that the anterior left atrial wall was a critical part of the reentrant circuit. Double anterior ablation lines from the mitral annulus at 12 o’clock to the roof of the left atrium could successfully terminate the atrial tachycardia.
anatomic mapping and entrainment mapping were performed prior to transeptal puncture. Activation around the mitral annulus was in a counterclockwise direction and entrainment manoeuvres proved that the anterior left atrial wall was a critical part of the reentrant circuit. In addition, the double anterior ablation lines from the mitral annulus at 12 o’clock to the roof of the left atrium could successfully terminate the atrial tachycardia (Figure 1C). Bidirectional block across the lines was confirmed, and no atrial tachycardia was inducible thereafter. However, when the patient was ready to leave the catheter room, chest fluoroscopy revealed a reduction in the excursion of the cardiac silhouette and a small amount of pericardial effusion, as confirmed by transthoracic echocardiography. The vital signs of this patient were stable and thus pericardiocentesis was not performed. A follow-up transthoracic echocardiography revealed no abnormality on the fifth day after the episode. The patient was thereby discharged from the hospital on the sixth day after the episode.

**Case 2**

A 58-year-old female was admitted to our cardiology unit for ablation of the symptomatic paroxysmal AF. Examinations on admission revealed the blood pressure of 112/80 mmHg, the respiration rate of 17/min, and the heart beat of 56/min. Both lungs were clear and no murmur could be heard. Chest radiography revealed normal bilateral lung fields and normal cardiac silhouette. Meanwhile, the transesophageal echocardiography ruled out the presence of left atrial thrombus and the transthoracic echocardiography presented normal left ventricular systolic function with the ejection fraction of 57%. ECG on admission suggested the presence of sinus bradycardia. Chest radiography revealed pericardial effusion when the ablation catheter was withdrawn from the right atrium (Figure 2A). Under such circumstances, emergency cardiac pulmonary resuscitation was performed, including intravenous epinephrine injection every 5 min for three doses and rapid administration of intravenous fluid to augment systemic output. Twenty minutes after the study, the patient had experienced hypotension and hypoxia. Thus, subxiphoid Seldinger puncture was performed immediately (Figure 2B). The patient resumed normal sinus rhythm and stable hemodynamic status one and half hours later. No remaining pericardial effusion was observed, as confirmed by pericardiography (Figure 2C). The ongoing bleeding with the drainage catheter in patient was monitored for 24 hours post ablation. A daily follow-up transthoracic ECG revealed no abnormality after the episode. The patient recovered and was discharged without other sequelae after 10 days.

**Case 3**

A 47-year-old man was admitted to our cardiology unit for ablation of the symptomatic paroxysmal AF and a right-sided accessory pathway (Figure 3). Physical examination upon admission revealed the blood pressure of 120/88 mmHg, the respiration rate of 16/min, and the heart beat of 84/min. Both lungs were clear and no murmur could be heard. Chest radiography revealed normal bilateral lung fields and normal cardiac silhouette. Transesophageal echocardiography ruled out the presence of left
atrial thrombus and transthoracic echocardiography showed normal left ventricular systolic function with the ejection fraction of 56%. ECG on admission suggested the presence of sinus rhythm with a right-sided accessory pathway. The catheters could be easily placed in the coronary sinus and the right ventricular. Unfortunately, the misdirected transseptal puncture was diagnosed when the guide wire was found in the thoracic aorta (Figure 4A, red arrows). About ten minutes later, chest fluoroscopy revealed a small amount of pericardial...
effusion. Subxiphoid Seldinger puncture was tried, but was not successful. 30 minutes later, the bleeding was increased (Figure 4A, yellow arrows), and the patient’s conditions became unstable, so pericardial drainage of 800 ml blood was performed via apical Seldinger puncture and auto-transfusion of the aspirated blood was used. After thirty minutes, the bleeding was decreased and the patient’s conditions became stable, then he was immediately transferred to the operating room, with the atrial septum puncture sheath being kept in the puncture site. A hematoma in the thoracic aorta region was observed and the ongoing bleeding was managed by double purse suture with tapetum. Additionally, the ongoing bleeding in the region of right atrium roof was similarly managed by mattress suture with tapetum (Figure 4B, blue arrows). Then, the left and right pulmonary veins were carefully separated and circle ablation of both right and left pulmonary veins was performed using a bipolar ablation clamp (OLL2 Isolator Synergy Clamp, Atricure Inc, 7555 Innovation way, Mason OH 45040, USA). All ablations were doubled to ensure electrical block. In the meantime, the LAA was resected and oversewn to avoid thrombi formation. No further complications were observed during his admission. The patient recovered and was discharged without other sequelae after two weeks. The ablation for the right-sided accessory pathway was scheduled three months later.

Discussion

Radiofrequency catheter ablation (RFCA) for atrial arrhythmia is one of the most complex interventional electrophysiological procedures, which involves catheter manipulation and ablation in the delicate thin-walled atria in close proximity to other vital organs and structures that may be affected through collateral damage by its nature. Therefore, it is not surprising that atrial arrhythmia ablation is associated with a marked risk of complications, some of which may result in the life-long disability and/or death [1]. Among them, cardiac tamponade remains the most common potentially life-threatening complication associated with atrial arrhythmia ablation [2]. In a dedicated worldwide survey, cardiac tamponade was reported to be the most frequent cause of peri-procedural death, which was related to the occurrence of 25% of all fatalities [6].

Compared with routine cardiac electrophysiology procedures, the incidence of cardiac tamponade during atrial arrhythmia ablation is markedly higher, which can be attributed to a number of important procedural differences, including extensive intracardiac catheter manipulation and ablation, the common need for two or more transseptal punctures, and the need for systemic anticoagulation [1-3, 7, 8]. An early sign of cardiac tamponade is the reduction in the excursion of the cardiac silhouette on fluoroscopy, along with a simultaneous decline in systemic blood pressure. Typically, the early recognition and rapid appropriate treatment of cardiac tamponade is mandatory to prevent the irreversible deterioration in perfusion of the brain and other important organs. Notably, percutaneous drainage can be best achieved by subxiphoid Seldinger puncture of the pericardial sac and placement of an intra-pericardial catheter. The pericardial tap can be performed either under fluoroscopic guidance based on anatomic landmarks or under echo guidance [9]. After the initial aspiration, the blood pressure can promptly return to normal. Once the pericardial space is drained, the patient should be monitored for the ongoing bleeding with the drainage catheter. In rare cases, percutaneous drainage may be inadequate in the presence of a tear, and surgical drainage and repair would be necessary [3]. One recent meta-analysis reported that 16% cases with cardiac tamponade required surgical intervention [10]. On this account, atrial arrhythmia ablation procedures should only be performed in hospitals equipped or prepared to manage these types of emergencies, with access to emergency surgical support when required. In this case, it is also important to maintain the sheath at the puncture site until surgical repair can be performed, since the sheath can decrease the bleeding.

Our search revealed 12 similar patients reported in the medical literature including our case report as well. These cases are summarized in Table 1. Iatrogenic injuries to the heart may occur in left atrium, right atrium, right atrial appendage, or inferior vena cava. Cardiac tamponade may occur immediately after the transseptal puncture [12], during or immediately after RFCA. Delayed cardiac tamponade is a rare major complication [13, 18]. Swissa M, et al. reported the case of a 67-year-old woman who developed cardiac tamponade re-
### Table 1. Summary of similar cases

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Year</th>
<th>Authors</th>
<th>Journal</th>
<th>Demographics (age, sex)</th>
<th>Diseases</th>
<th>Site</th>
<th>Time</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2009</td>
<td>Bahcivan M, et al. [12]</td>
<td>Interact Cardiovasc Thorac Surg</td>
<td>42 years, female</td>
<td>supraventricular tachycardia with AF</td>
<td>left atrium's roof</td>
<td>After the transseptal puncture</td>
<td>Combination of interventional and surgical treatment</td>
</tr>
<tr>
<td>4</td>
<td>2010</td>
<td>Lambert T, et al. [13]</td>
<td>Clin Res Cardiol</td>
<td>68 years, male</td>
<td>paroxysmal AF</td>
<td>-</td>
<td>18 days after the second RFCA</td>
<td>pericardiocentesis</td>
</tr>
<tr>
<td>5</td>
<td>2011</td>
<td>Vergara GR, et al. [14]</td>
<td>Europace</td>
<td>74 years, male</td>
<td>chronic atrial fibrillation</td>
<td>right atrial appendage</td>
<td>the end of RFCA</td>
<td>Urgent exploratory surgery</td>
</tr>
<tr>
<td>6</td>
<td>2012</td>
<td>Liu P, et al. [15]</td>
<td>Ann Thorac Cardiovasc Surg</td>
<td>64 years, male</td>
<td>paroxysmal AF</td>
<td>left atrium, right atrium</td>
<td>Thirty minutes after RFCA</td>
<td>Urgent exploratory surgery</td>
</tr>
<tr>
<td>7</td>
<td>2013</td>
<td>Kiliszek M, et al. [16]</td>
<td>Kardiol Pol</td>
<td>52 years, male</td>
<td>persistent AF</td>
<td>-</td>
<td>Shortly after transseptal puncture</td>
<td>no pericardial drainage</td>
</tr>
<tr>
<td>8</td>
<td>2013</td>
<td>Kiliszek M, et al. [16]</td>
<td>Kardiol Pol</td>
<td>68 years, male</td>
<td>paroxysmal AF and atypical atrial flutter</td>
<td>-</td>
<td>After transseptal puncture</td>
<td>no pericardial drainage</td>
</tr>
<tr>
<td>9</td>
<td>2013</td>
<td>Kiliszek M, et al. [16]</td>
<td>Kardiol Pol</td>
<td>63 years, female</td>
<td>paroxysmal AF</td>
<td>-</td>
<td>During RFCA</td>
<td>no pericardial drainage</td>
</tr>
<tr>
<td>10</td>
<td>2013</td>
<td>Swissa M, et al. [17]</td>
<td>Isr Med Assoc J</td>
<td>67 years, female</td>
<td>atrial flutter and atrial fibrillation</td>
<td>Rupture of Inferior Vena Cava-Right Atrial Free Wall</td>
<td>Three months after RFCA</td>
<td>Pericardiocentesis and surgery</td>
</tr>
<tr>
<td>11</td>
<td>2015</td>
<td>Torihashi S, et al. [18]</td>
<td>Intern Med</td>
<td>49 years, male</td>
<td>persistent AF</td>
<td>-</td>
<td>16 days after RFCA</td>
<td>Pericardiocentesis</td>
</tr>
<tr>
<td>12</td>
<td>2015</td>
<td>Torihashi S, et al. [18]</td>
<td>Intern Med</td>
<td>49 years, male</td>
<td>persistent AF</td>
<td>-</td>
<td>26 days after RFCA</td>
<td>Pericardiocentesis</td>
</tr>
</tbody>
</table>
quiring pericardiocentesis and surgical repaired 3 months after undergoing multiple radiofrequency ablations [17]. Careful monitoring of the cardiac silhouette can reduce the number of cardiac tamponade complications [16]. Once the diagnosis of cardiac tamponade is made, a pericardiocentesis should be performed immediately. Urgent cardiac surgery is indicated if hemodynamic instability still exists after pericardiocentesis [15].

In most instances, catheter ablation is preferred over surgical ablation, but the latter is favored if catheter ablation is unlikely to succeed or is not feasible. The pulmonary veins can be surgically isolated by the endocardial route after opening the left atrium or by the epicardial route. Cox-Maze III and IV are the most successful therapeutic options from the surgical standpoint [19], but the technical complexity and degree of invasiveness of such approaches have restricted their wide acceptance among patients and cardiologists. Therefore, there has been an increasing interest towards the less invasive off-pump surgical techniques for AF treatment in the past decade. The minimally invasive and epicardial-endocardial ablation procedures have been developed, which can be ascribed to the demand for open heart surgery and the morbidity associated with the surgical Cox-Maze procedure [1]. The epicardial method is mainly advantageous in that the pulmonary veins can be isolated without left atriotomy or on a beating heart, thus simplifying the surgical procedure and reducing the risks of complications. Benussi et al. had described an original radiofrequency ablation technique to treat AF in patients undergoing mitral valve surgery, in which two encircling lesions around the ostia of the right and the left pulmonary veins were performed epicardially, and the endocardial lesions connecting the encircling between them and to the mitral valve annulus were also completed. At a mean follow-up of 11.6 ± 4.7 months, 76.9% patients were in stable sinus rhythm [4]. Accordingly, the epicardial AF ablation was performed after surgical repair in this case.

The LAA has an anatomic structure that is quite favorable for thrombus formation in AF patients who often experience limited contraction and stagnant blood flow. Retrospective evaluation has suggested that LAA is responsible for up to 90% of strokes in patients with AF and non-rheumatic heart disease [20]. Surgical treatment of LAA has been increasingly performed over the past few years. According to the ACC/AHA/ESC guidelines, LAA should be excluded when mitral valve or other cardiac surgery is performed in AF patients [5]. Surgical exclusion of LAA can be achieved either endocardially or epicardially by over-sewing or excision or epicardially only by resection, ligation and stapling with or without amputation of LAA, or application of a clip system at the bottom of LAA [21]. In our case, the LAA was amputated after epicardial AF ablation.

In conclusion, cardiac tamponade is still the most common potentially life-threatening complication related to catheter ablation. Therefore, the early recognition and rapid appropriate treatment of cardiac tamponade play a vital role in preventing the irreversible deterioration in perfusion of the brain and other key organs. Besides, it is necessary to maintain the sheath at the puncture site before surgical repair can be performed. Epicardial AF ablation and LAA amputation are alternatives during the surgical repair in patient with AF.

Disclosure of conflict of interest

None.

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References

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citation on catheter and surgical ablation of atrial fibrillation. Circulation 2018; 20: e1-e160.


cases of delayed cardiac tamponade due to pericarditis after pulmonary vein (PV) isolation for atrial fibrillation. Intern Med 2015; 54: 791-796.

