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Late Diaphragmatic Paralysis After Atrial Fibrillation Cryoablation

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Abstract

Atrial fibrillation (AF), a common cardiac arrhythmia, is often managed with catheter ablation, specifically cryoablation, to electrically isolate pulmonary veins by tissue freezing. Despite its effectiveness, a significant complication is phrenic nerve injury, which can result in diaphragmatic paralysis. This case report presents a 70-year-old female with a history of coronary artery bypass surgery, hypertension, and diabetes, who underwent AF cryoablation. Post-operatively, she was asymptomatic and discharged in sinus rhythm. However, several weeks later, she developed dyspnea and was diagnosed with right diaphragmatic paralysis due to phrenic nerve injury. Initial management included respiratory therapy, leading to significant symptom improvement and partial recovery of diaphragmatic movement within two months. The discussion highlights the prevalence, causes, and management of early and late phrenic nerve injuries, emphasizing the need for early diagnosis and appropriate treatment to ensure patient recovery.

Keywords: Atrial fibrillation cryoablation, late diaphragmatic paralysis, phrenic nerve palsy

Introduction

Atrial fibrillation (AF), a prevalent cardiac arrhythmia, is frequently managed with catheter ablation. Cryoablation is a common method for electrically isolating the pulmonary veins through tissue freezing. However, a significant complication of this procedure is injury to the phrenic nerve, potentially resulting in diaphragmatic paralysis.

Case Presentation

A 70-year-old female was referred to the cardiology outpatient clinic complaining of palpitations. AF cryoablation was planned for the patient, who has a known history of coronary artery bypass surgery, hypertension, and diabetes. In our center, ablation procedures were conducted with deep sedation utilizing intermittent doses of midazolam and fentanyl for all

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patients. Throughout the procedure, oxygen saturation and electrocardiography (ECG) findings were monitored non-invasively. The right femoral vein and left femoral vein/artery were accessed by using the Seldinger technique. A 6 French steerable decapolar catheter was inserted into the coronary sinus. A single transseptal puncture was performed using fluoroscopic guidance and a modified Brockenbrough technique (BRK-1 transseptal needle; St. Jude Medical, St. Paul, MN, USA), with the insertion of an 8.5 French transseptal sheath (Fast-Cath transseptal guiding introducer, St. Jude Medical, St. Paul MN, USA) into the left atrium (LA). Immediately following transseptal puncture, unfractionated heparin was administered to maintain an activated clotting time of at least 300 s. The transseptal sheath was then exchanged over a guidewire (0.032 in., 180 cm Super Stiff, St. Jude Medical, St. Paul, MN, USA) for a 12 French steerable sheath (Flexcath Advance; Medtronic, Minneapolis, MN, USA). A 15-or 20-mm circular mapping catheter (Achieve, Medtronic, Minneapolis, MN, USA) was used to guide the cryoballoon within the LA and attempt real-time recordings from the targeted pulmonary vein. The balloon was inflated within the LA and directed toward the pulmonary vein ostia. Balloon occlusion was assessed by injecting contrast agent through the central lumen of the catheter. Each freezing cycle lasted 180-240 seconds, with an additional freeze applied if the pulmonary vein isolation was not obtained beyond 60 s. 20 mm, 4th generation Achieve catheter was used. Right phrenic nerve stimulation is always performed during freezing of right pulmonary veins and right hemidiaphragm contraction is assessed manually until balloon deflation. High-output pacing was performed using the ablation catheter during ablation near the pulmonary veins on the right side and output pacing was performed through the ablation catheter. Same procedure was performed in aforementioned case and right diaphragmatic movement was intact both after right upper and lower pulmonary vein balloon deflation. Post-operative course was uneventful and patient was discharged in sinus rhythm following day without any relevant complications. After the procedure, chest radiography was normal and 12 lead ECG showed sinus rhythm (Figure 1).

However, 4 weeks after the procedure, the patient presented with dyspnea with effort capacity. A physical examination revealed decreased breath sounds on the right hemithorax. An elevated right hemidiaphragm was noted plain chest radiography (Figure 2). The patient was initially managed conservatively with respiratory therapy. At the two-month follow-up, the patient's symptoms had significantly improved, and repeat imaging showed partial recovery of the diaphragmatic movement (Figure 3).

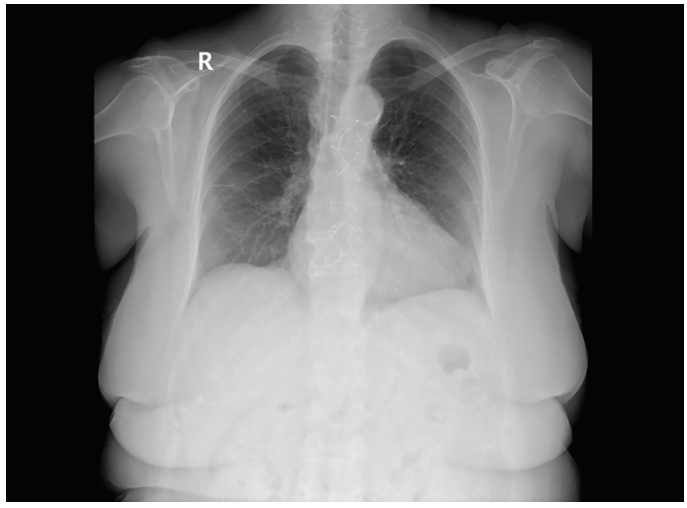

Figure 1. Chest radiography after the procedure

Figure 2. Right diaphragmatic elevation observed four weeks post-procedure

Discussion

In this case, late phrenic nerve paralysis (PNP) was observed. The development of shortness of breath, not evident during the procedure but evident during follow-up assessments, may indicate the development of late phrenic nerve injury. Phrenic nerve injury during cryoablation typically occurs because of the close anatomical proximity of the right phrenic nerve and right pulmonary veins[1] and the prevalence has been reported to be between 3-7% after cryoablation of AF[2,3]. However, early and late PNP are two distinct complications that can occur after cryoablation of pulmonary veins, each with its own characteristics and management considerations[4]. The primary cause of early paralysis is the direct injury to the phrenic nerve during ablation. Late paralysis is often caused by inflammatory or edematous changes that develop post-procedure, leading to compression or irritation of the phrenic nerve[5,6]. In the current case, the mechanisms of delayed inflammatory response, progressive edema and cryoablation lesion expansion related to late-onset PNP were considered. Further investigation into these potential mechanisms is necessary to better understand and prevent late-onset PNP in future patients.

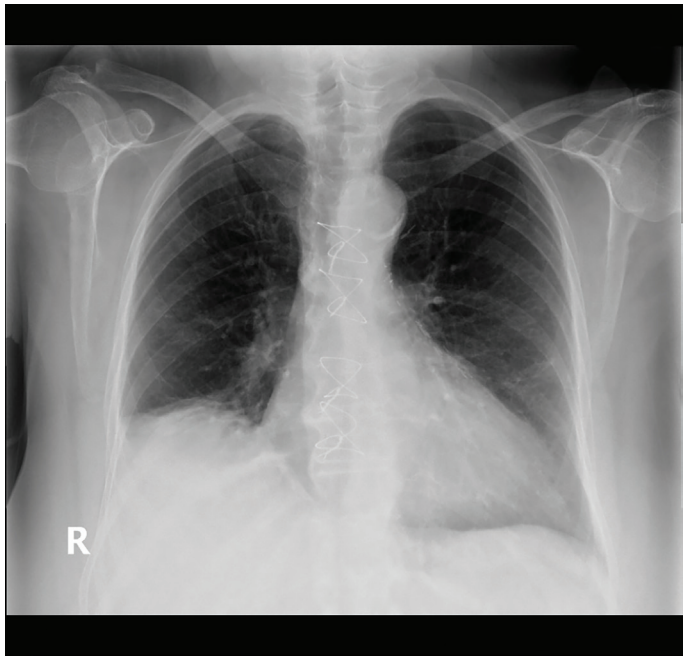

Figure 3. Partial recovery of the right hemidiaphragm

Conclusion

Phrenic nerve injury leading to right hemi diaphragmatic paralysis is a potential late complication of AF cryoablation. One should always consider late diaphragmatic paralysis due to right phrenic nerve injury in differential diagnosis of dyspnea after cryoballoon isolation of pulmonary veins due to AF. Early diagnosis and appropriate management are crucial for patient recovery.

Ethics

Informed Consent: Informed consent was obtained from the patient before the procedure.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Çakmak Karaaslan Ö, Güray Ü., Concept: Çakmak Karaaslan Ö, Güray Ü., Design: Çakmak Karaaslan Ö, Güray Ü., Data Collection and/or Processing: Çakmak Karaaslan Ö, Güray Ü., Analysis and/or Interpretation: Çakmak Karaaslan Ö, Güray Ü., Literature Search: Çakmak Karaaslan Ö, Güray Ü., Writing: Çakmak Karaaslan Ö, Güray Ü.

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