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Case Report
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Prolonged Phrenic Nerve Palsy during Cryoballoon Ablation of Paroxysmal Atrial Fibrillation in an Octogenarian Female: A Case Report

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Abstract

Introduction: Phrenic nerve palsy (PNP) is a recognized complication of cryoballoon ablation (CBA) for paroxysmal atrial fibrillation (AF). The right superior pulmonary vein (RSPV) is particularly vulnerable due to its proximity to the phrenic nerve. This case report highlights the importance of meticulous monitoring and prompt management of PNP during CBA, especially in elderly patients, to prevent permanent nerve injury.

Case Presentation: An 80-year-old female with hypertension and recurrent paroxysmal AF refractory to amiodarone underwent CBA using a 28 mm fourth-generation cryoballoon catheter. During ablation of the RSPV, significant weakening of diaphragmatic movement was observed after 92 seconds at a minimum temperature of -52°C. CBA was immediately halted, and intravenous methylprednisolone sodium succinate (40 mg) was administered, leading to temporary recovery. Upon resuming ablation, PNP recurred and persisted despite further steroid administration. Postoperatively, the patient received intravenous methylprednisolone for three days but did not show recovery of diaphragmatic movement by the time of discharge. The patient remained asymptomatic with stable oxygen saturation and no respiratory compromise.

Conclusion: This case underscores the importance of continuous phrenic nerve monitoring during CBA of the right pulmonary veins. Despite the use of advanced cryoballoon technology and prompt steroid administration, prolonged PNP can still occur. Immediate cessation of ablation and administration of corticosteroids are essential in managing PNP. In cases of persistent PNP, alternative ablation modalities should be considered to prevent further nerve injury. This case highlights the need for careful risk assessment and management strategies to optimize patient outcomes.

Keywords: Phrenic nerve palsy, Cryoballoon ablation, Paroxysmal atrial fibrillation, Fourth-generation cryoballoon, Case report

Introduction

Phrenic nerve palsy (PNP) is a known complication of cryoballoon ablation (CBA) for atrial fibrillation (AF). We report a case of an 80-year-old female who developed prolonged PNP following CBA, highlighting the importance of meticulous monitoring and prompt management to prevent permanent PNP.

Case Presentation

An 80-year-old female with a history of hypertension was admitted for CBA of paroxysmal AF. She had experienced several episodes of AF during the last three months, each lasting several hours, despite treatment with amiodarone. Hypertension was treated with valsartan. Considering the patient's symptoms and resistance to medical therapy, CBA was selected as the therapeutic approach.

Procedure

After the exclusion of left atrial thrombus by transesophageal echocardiogram, the procedure was performed under conscious sedation. A ten-polar electrode catheter was placed in the coronary sinus via the left femoral vein. A single transseptal puncture was performed, and a 14-F steerable sheath (FlexCath Advance, Medtronic) was placed. Considering the preoperative CTA results of the PVs, a 28mm fourth-generation cryo balloon catheter (Arctic Front Advance, Medtronic) was used for pulmonary veins isolation (PVIs). Optimal vessel occlusion was considered to be achieved when selective contrast injection revealed total contrast retention with no backflow into the atrium. Once occlusion was confirmed, cryothermal energy was started.

During ablation of the right superior pulmonary vein (RSPV), the phrenic nerve was continuously monitored using a decapolar catheter placed in the superior vena cava (Fig 1).

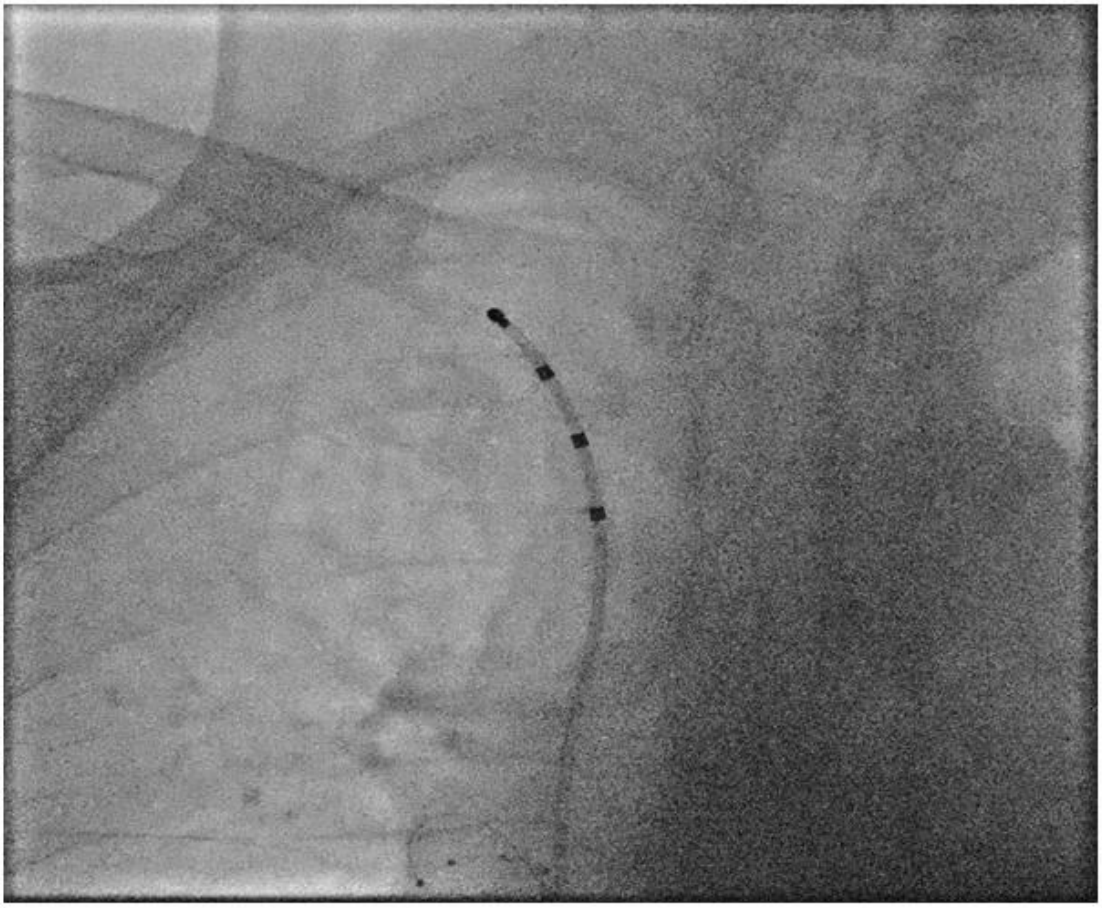

Fig 1: A decapolar catheter placed in the superior vena cava

High-output pacing was delivered to a widely spaced bipole (poles 1 and 4 at 8V and 2.0 ms pulse width at a cycle length of 1500 ms). After 92 seconds, with a minimum temperature of -52°C, a significant weakening of diaphragmatic movement was observed during the ablation of the RSPV (Video 1).

Video 1.wmv

Video 1: Right hemidiaphragm in the right anterior oblique projection.After CBA of the RSPV, the contraction of the right hemidiaphragm disappeared.CBA = cryoballoon ablation; RSPV=right superior pulmonary vein.

CBA was immediately halted, and intravenous methylprednisolone sodium succinate 40mg was administered. After a few minutes, the diaphragmatic movement recovered (Video 2).

Video 2.wmv

Video 2: Right hemidiaphragm in the right anterior oblique projection. After a few minutes of administering methylprednisolone sodium succinate, the right hemidiaphragm resumed contraction.

The ablation was restarted on the RSPV, and this time freezing lasted 112 seconds, with a minimum temperature of -53°C. Unfortunately, diaphragmatic movement again diminishand despite repeated administration of methylprednisolone, recovery did not occur (Video 3).

Video 3.wmv

Video 3: Right and left hemidiaphragm in the left anterior oblique projection. At the end of the procedure, the right hemidiaphragm had not yet resumed contraction, while the left hemidiaphragm exhibited regular contractions.

The patient, however, remained asymptomatic, with stable oxygen saturation levels and no complaints of dyspnea or chest discomfort. Subsequent CBA of the left pulmonary veins (PVs) were successfully completed. Radiofrequency ablation (RF) was also performed for the right PVs, resulting in successful PVIs.

Outcome and Follow-Up

Postoperatively, the patient was treated with intravenous methylprednisolone 40mg daily for three days. However, diaphragmatic movement on the right side did not recover by the time of discharge. The patient remained asymptomatic, with no respiratory compromise.

Discussion

PNP is a recognized complication associated with CBA for AF, with an incidence ranging from 1.14% to 11.2% in published series[1-3]. The right PVs are very close to the right phrenic nerve, especially the RSPV, with statistics showing that 32% of the anterior walls of the RSPVs are less than 2 mm away from the right phrenic nerve[4]. Therefore, the phrenic nerve is prone to injury during CBA of the RSPV.

There is no reliable method for predicting phrenic nerve injury (PNI) before the procedure. Based on the preoperative CTA results of the PVs, a 28mm fourth-generation cryoballoon catheter is selected to improve thermal distribution and reduce the risk of PNP. This approach ensures that the phrenic nerve is closely monitored during ablation to prevent potential damage. The selection of the cryoballoon size and monitoring of the phrenic nerve are crucial steps to enhance the safety and effectiveness of the procedure.

Although the incidence of PNP is generally low and most cases are transient[5], the outcome of this patient serves as a reminder that we overlooked the vulnerability of the phrenic nerve. Upon the first discovery of weakened diaphragmatic movement, CBA was immediately halted, and 40mg of methylprednisolone sodium succinate was administered intravenously. After a few minutes of observation, the diaphragmatic movement resumed. Methylprednisolone, a corticosteroid known for its anti-inflammatory properties, was employed to reduce nerve inflammation and facilitate recovery. Histopathological analysis of cryoballoon-induced PNI reveals a pattern of axonal damage due to Wallerian degeneration, the degree of which paralleled functional effects on diaphragmatic motion[6]. However, PNP occurred after resuming ablation of the RSPV. Despite continued administration of methylprednisolone sodium succinate postoperatively, the diaphragmatic movement had not recovered by the time of the patient's discharge. This outcome suggests that the nerve injury may have been more severe than initially anticipated.

The prolonged nature of PNP in this case, which did not recover by the time of discharge, is less common but has been reported in the literature, while PNI associated with AF ablation typically recovers spontaneously within 12 months in most cases, regardless of the energy source used[7].

In conclusion, this case emphasizes the importance of monitoring the phrenic nerve during cryoablation of the right PVs. Although apply3ng fourth-generation cryoballoons and 14F steerable sheaths can enhance ablation efficiency and reduce the risk of phrenic nerve injury, some patients may still experience PNI, including PNP. Upon detecting PNP, immediate cessation of ablation is warranted; administration of steroids can effectively promote recovery of the phrenic nerve, preventing re-attempting cryoablation. Switching to alternative ablation modalities can prevent further damage to the phrenic nerve.

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Data Availability The datasets used are available from the corresponding author on request.

Code Availability No specific computer code was used in this report.

Ethical Approval Our institution does not require ethical approval for reporting individual cases or case series.

Consent to Participate Not applicable.

Written Consent for Publication The patient provided written informed consent for her case details to be published.

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