Case Report

Postintervention Dyspnea after Radiofrequency Catheter Ablation: Think of a Phrenic Nerve Injury

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Phrenic nerve injury (PNI) is a rare complication of catheter ablation therapy, most commonly observed in cryoablation of the right side pulmonary veins. We present a case of PNI after radiofrequency catheter ablation that developed acute dyspnea 24 hours after the intervention. Dyspnea is the main symptom of PNI, so the diagnosis should always be suspected if it appears after any type of catheter ablation involving the trajectory of the phrenic nerve. There is no specific treatment for PNI. The only maneuver that has been reported to accelerate the recovery of PNI is early stopping of the ablation therapy.

1. Introduction

Phrenic nerve injury (PNI) is a rare complication of atrial fibrillation (AF) ablation [1]. Its prevalence is higher with cryoablation (approximately 5%) than radiofrequency catheter ablation (RFCA; less than 1%) and therefore the development of diaphragmatic paralysis is monitored during the former procedure [2]. Although most cases of diaphragmatic paralysis show full recovery, it could be a potentially disabling complication [3]. We report a case of diaphragmatic paralysis secondary to PNI in the context of an uneventful RFCA of pulmonary veins, manifested as acute dyspnea 24 hours after the intervention.

2. Case Report

A 51-year-old woman with diabetes mellitus, systemic arterial hypertension, bypass surgery, and obesity underwent RFCA of the pulmonary veins due to paroxysmal AF. Under conscious sedation, Lasso and Cordis 7-Fr catheters were used to map the left atrium and pulmonary veins (EnSite electroanatomic mapping system, St. Jude Medical, USA). Energy applied was limited to a power of 20 W achieving maximum temperature of 45°C. Radiofrequency applications, a total of 531 points giving 340 points to both right pulmonary veins, had an average length of 3 to 4 minutes per vein resulting in elimination of pulmonary vein action potentials (Figure 1). As routinely for RFCA, no phrenic nerve stimulation was performed during ablation of right pulmonary veins. During the procedure and immediate postoperative period the patient did not have any symptoms. The following day, on prone position and under routine supplementary oxygen she reported mild dyspnea that increased with sitting. Without supplementary oxygen, she developed oxygen desaturation of 85%. Pulmonary physical exploration showed absence of breathing sounds at the right base. Chest radiograph showed elevated right hemidiaphragm (Figure 2). ECG confirmed sinus rhythm and the echocardiogram was normal. The diagnosis of diaphragmatic dysfunction secondary to RFCA was made. The patient did not require noninvasive mechanical ventilation. She experienced complete recovery of symptoms with pulmonary physical therapy. Asymptomatic paralysis persisted in a 10-month follow-up (Figure 3).

3. Discussion

PNI in the context of RFCA has been reported in ablation of pulmonary veins (mostly right but also left) and ablation...
of superior vena cava (SVC) [4] and even in inappropriate sinus tachycardia [5]. The occurrence of PNI during RFCA for AF has been limited to case reports [6] and its prevalence in the context of RFCA for AF is low (0.48%) with a reported permanent damage of 0.17% [7]. It has been reported to occur more frequently in patients that underwent wide-area circumferential ablation whereas Yong reported an incidence of 30% [8]. The most common scenario in which PNI has been reported is cryoballoon ablation of the right-sided pulmonary veins. This has been observed in 8 to 11% of cryoablation procedures and was largely reversible. The mechanism of the occurrence of PNI is probably related to positioning the balloon further into the right pulmonary veins, as the phrenic nerve may run behind the right atrium. Such is the case as the undersizing of the balloon to a 23-mm versus a 28-mm balloon relative to the size of the vein that could contribute to this complication [9].

Three mechanisms might have been implicated in PNI: (1) direct heat transfer from the catheter contact site to the nerve, regardless of the energy source used for ablation; (2) effect of a high intensity electromagnetic field transiently generated at the catheter tip; (3) generation of a resonance current around the heart; furthermore, the PN is more sensitive to injury during ablation of the RSPV than during ablation of the Right Inferior Pulmonary Vein (RIPV). Ablation to achieve pulmonary vein isolation (PVI) has been highly successful in the management of AF. However, it is also associated with a variety of complications including PNI. The anatomic course of the phrenic nerve near the RSPV predisposes them to injury during the ablation.

Up to 31% of patients remain asymptomatic, but diaphragmatic dysfunction is an underdiagnosed cause of dyspnea and should always be considered as a differential diagnosis. Although dyspnea remains the cardinal symptom, the severity of it can vary depending on coexisting conditions such as obesity, weakness of other muscle groups, or underlying heart and lung disease, especially when they are supine [1]. Physical exploration reveals tachypnea, use of accessory muscles, and decreased diaphragmatic excursion can be detected by percussion of the lower rib cage at end expiration and end inspiration. The most characteristic physical sign is abdominal paradox, which is paradoxical inward motion of the abdomen as the rib cage expands during inspiration especially in supine position, and when this occurs in unilateral diaphragmatic paralysis, it suggests generalized weakness of the respiratory muscles. The diagnosis can be confirmed by a number of tests but the easiest one is the chest X-ray which shows elevated hemidiaphragm and basal subsegmental atelectasis [11]. Dyspnea could be resolved only with supplementary oxygen but, in some cases with severe respiratory distress, patients may require a few days of ventilatory support with noninvasive positive pressure ventilation or even invasive mechanical ventilation.

Early detection of PNI with phrenic nerve pacing is now the standard procedure during cryoablation in order to detect PNI earlier, to stop cryotherapy immediately, and to accelerate recovery of the injured nerve. Many strategies have been reported to be useful to avoid PNI in this setting. Some authors have postulated that preprocedural imaging could help to delineate the phrenic nerve course and therefore to avoid a PNI [12, 13]. Horton et al. [14] reported a novel method of localization of the phrenic nerve with cardiac computed tomography and found that the imaged pericardiophrenic artery could reliably identify the approximate location of the RPV, suggesting that a phrenic nerve location within 10 mm of the RSPV poses a higher risk of PNI using balloon ablation devices. The improved temporal and spatial resolution allowed by multidetector computed tomography (MDCT) has facilitated the noninvasive assessment of cardiac anatomy before transcatheter electrophysiologic procedures. Clarification of spatial relations of phrenic nerves and key cardiac structures is important to decrease potential complications. The RPV was identified in 50 of 106 patients (47%). In the setting of electrophysiologic interventions, MDCT before a procedure may elucidate anatomic relationships and help minimize inadvertent complications [15]. In animals (rats) proximity of the ablation catheter to the phrenic nerve may be identified by capture during pacing [16]. Balloon inflation in the pericardial space has been described to protect the left phrenic nerve in the setting of epicardial ventricular tachycardia ablation. Nevertheless, techniques to protect the RPV during endocardial atrial ablation procedures have not been well described [17]. The likelihood of PNI associated with ablation using certain energy sources, the clinical course of this complication, and the possibility of recovery of PN function have not been reported [18]. The only parameter that predicts recovery has been the early interruption of the
energy delivery. Short term outcomes from published cases are favorable with 81% of patients having a complete recovery after 6-7 months; however the recovery period can be as long as 28 months [1]. PNI has also been reported to occur with other energy sources for catheter ablation. It has been reported with radiofrequency hot balloon in 3.4% of cases and resolved in less than 3 months [19].

4. Conclusion

PNI is an uncommon complication of catheter ablation. It has been reported to be most commonly associated with atrial fibrillation ablation. It is important to consider PNI in the differential diagnosis of acute dyspnea after this intervention. Currently there is no reliable method to predict RPN injury prior to procedure. However, implementing vigorous monitoring of the nerve function can assure early detection and prevent permanent RPN. Because of this, it is very interesting for electrophysiologists and laboratory staffs to be familiar with and recognize this injury at the earliest to mitigate the damage.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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