



Rapid firing

Eccentric scar formation around a pulmonary vein after cryo-balloon ablation in a patient with atrial fibrillation: A case report

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ABSTRACT

The impact of a cryoballoon ablation is reported to be similar to that of a radiofrequency (RF) ablation in patients with atrial fibrillation. Delayed enhancement magnetic resonance imaging (DE-MRI) could visualize the scar region induced by the cryoballoon ablation as well as RF ablation. Cryoballoon ablation could induce extensive scar lesions around the PVs. However, the distribution of the scar lesions after the cryoballoon ablation has not been well discussed. We, herein, described a case with an eccentric scar distribution after cryoballoon ablation.

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1. Case report

A 62-year-old man with palpitations was referred to our center for catheter ablation due to a paroxysmal atrial tachycardia (AT). During the first procedure, the pulmonary veins (PVs) could be isolated by the cryoballoon ablation of his paroxysmal atrial fibrillation. The PV isolation (PVI) using the cryoballoon was difficult, especially for the left inferior PV (LIPV) due to the adjacent inferior branch of the left superior PV (LSPV) (Fig. 1A).

An atrial tachycardia (AT) was induced after the PVI. The AT was considered to be a peri-mitral atrial flutter by an entrainment study around the mitral annulus. However, a mitral isthmus ablation was not attempted because it was a non-clinical peri-mitral flutter. Six months after the first procedure, a paroxysmal AT recurred.

Delayed enhancement magnetic resonance imaging (DE-MRI) demonstrated an eccentric cryothermal lesion around the LIPV. In addition, an extensive cryothermal lesion was located on the anterior wall of the LIPV and a lesion gap was seen on the posterior wall of the LIPV (Figs. 1B and C, and 2). A PV-left atrium (LA) re-conduction was documented in both the LSPV and LIPV during the second procedure. Several radiofrequency (RF) applications at the cryothermal lesion gap could achieve PV-LA conduction block.

The AT was considered to be a peri-mitral atrial flutter because the P-wave morphology was similar to that of the induced peri-mitral atrial flutter during the first procedure. However, no AT could be induced by any programmed stimulation during an isoproterenol infusion. Therefore, we empirically attempted to create a mitral isthmus line. Detailed mapping at the mitral isthmus was performed during sinus rhythm, and a voltage map demonstrated a localized low voltage area on the anterior wall of the LIPV where a delayed dull potential was recorded during left atrial appendage pacing (Figs. 1D and 2). A single sharp potential was recorded between the extensive cryothermal lesion and mitral annulus (Fig. 2). A single RF application at that site could achieve a significant conduction delay across the mitral isthmus. A complete bidirectional block was achieved after 3 additional RF applications near the mitral annulus. There has been no recurrence of AT as of the last available follow-up (9 months).

A multi-center study reported that DE-MRI could visualize RF lesions as well as a preexisting atrial fibrosis after AF ablation [1]. We also reported that the exact localization of RF lesions could be recognized by DE-MRI fused with magnetic resonance angiography [2]. The lesion gap assessed by DE-MRI is reported to correspond to the electrical re-conduction sites verified by an ablation catheter or ring catheter [3]. Furthermore, we reported that the dense enhancement sites and patchy sites assessed by DE-MRI could correspond to an arrhythmogenic substrate [4]. However, it has not been well discussed whether the cryothermal lesions after cryoballoon ablation can be visualized by DE-MRI. In

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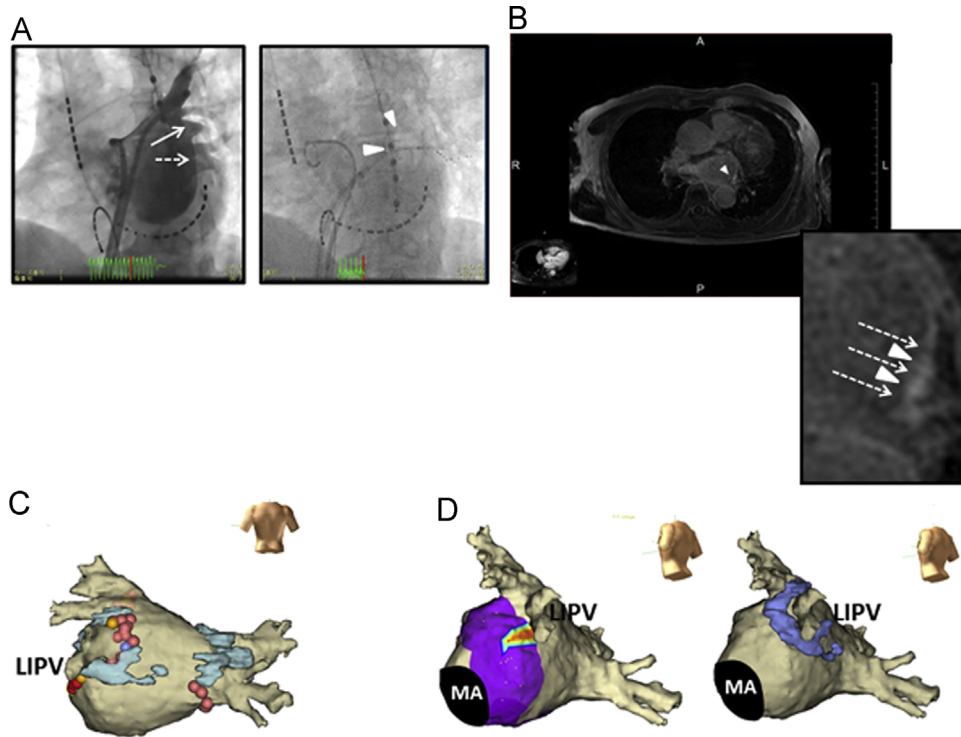


Fig. 1. A: Angiography of the PVs and LA during ventricular burst pacing (left panel) and cryoballoon ablation of the left inferior pulmonary vein (right panel). The white arrow indicates the inferior branch of the LSPV. The white dotted arrow indicates the LIPV. The white arrows indicate the dilated cryoballoon. B: DE-MRI of the LA and PV in an axial view at the LIPV level. The white arrowheads indicate a delayed-enhancement area around the mitral isthmus (left panel). The enlarged view of the mitral isthmus. The white arrowhead and dotted arrow indicate the high and relatively low signal intensity areas, respectively (right panel). C: The three dimensional (3D) reconstructed DE-MRI by a NavX system. The light blue objects indicate the delayed-enhancement area. The 3D pink and red tags indicate the ablation points with 20 and 30 W, respectively. The 3D orange tags indicate the successful ablation sites. D: Voltage map of the lateral wall of the LA during SR (left panel) and three dimensional (3D) reconstructed delayed-enhancement sites (right panel). The purple areas indicate the healthy areas with a voltage of > 0.5 mV during SR. LA=left atrium, PV=pulmonary vein, LSPV=left superior pulmonary vein, LIPV=left inferior pulmonary vein, DE-MRI=delayed-enhancement magnetic resonance imaging, SR=sinus rhythm.

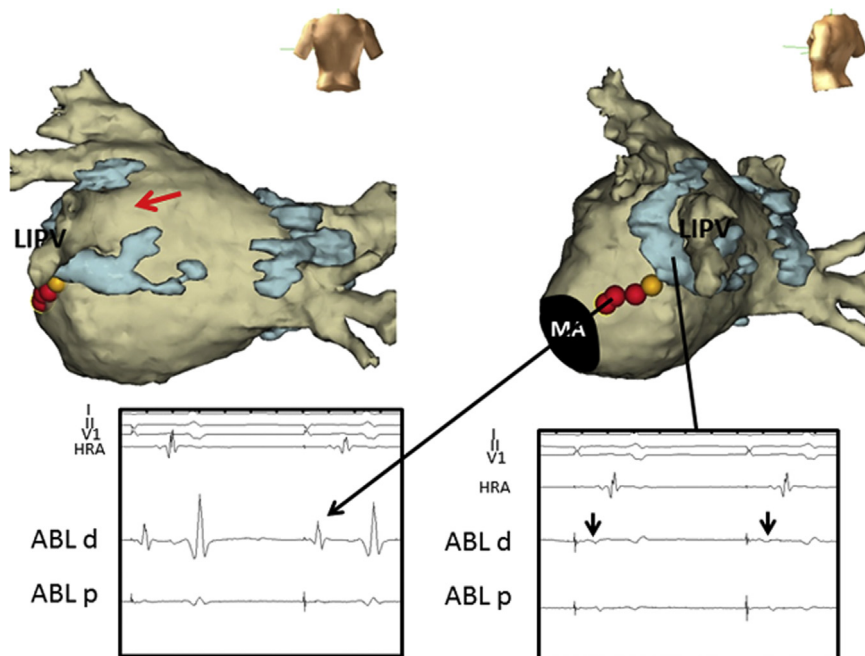


Fig. 2. Three dimensional (3D) reconstructed DE-MRI using a NavX system in the PA (left panel) and lateral views (right panel). The light blue objects indicate delayed-enhancement sites assessed by the DE-MRI. This shows the electrograms recorded by the ablation catheter at the sites with and without delayed-enhancement (lower panel). The black arrow in the lower panel indicates a delayed dull potential during LAA pacing. The red arrow indicates the cryothermal ablation gap. The 3D orange and red tags indicate the ablation points for achieving the conduction block of the mitral isthmus. DE-MRI=delayed-enhancement magnetic resonance imaging, LAA=left atrial appendage, MI=mitral isthmus.

this case, DE-MRI could demonstrate a small but high signal intensity area located on the anterior wall near the LIPV. Furthermore, Fig. 1B shows a relatively low signal intensity area located between the high signal intensity areas.

A delayed enhancement area was defined as the area with a signal intensity of > 3 SD, to avoid an overestimation of non-specific atrial fibrosis. Considering the small area and high threshold of the high intensity area, this patchy scar was induced by a cryothermal lesion, not by any preexisting atrial fibrosis. Furthermore, the cryothermal lesions assessed by DE-MRI were characterized as follows: both the width and signal intensity of the lesion were likely to be greater than that after a conventional RF ablation. In previous reports, it was believed that the width and signal intensity might be associated with the durability of the cryothermal lesion and an increased creatinine phosphokinase level [5]. In cryoballoon ablation, it is reported that the cryothermal lesion extends to the antral region around the PVs [5]. However, the cryothermal lesions around the PVs depend on the PV and LA anatomy. If the longitudinal axis of the PV and the cryoballoon catheter are coaxial, the PVI could be achieved easily and an extensive cryothermal lesion could be achieved concentrically around the PV. If not, the PVI may be difficult and the cryothermal lesion may be smaller and eccentric. The accuracy of DE-MRI in detecting cryothermal lesion gaps after cryoballoon ablation may be reliable.

Conflict of interest

The authors declare no conflicts of interest.

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