

# Antral lesion characterization of a new cryoballoon ablation system in terms of local impedance drop: The first reported case



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## Introduction

Freezing or heating affects biological systems at both nanoscale (molecular) and microscale (cellular) levels, which may cause change in their structure and composition and therefore their electrical impedance.<sup>1</sup> Experimental results indicate that during cryoablation, progressive ice formation in the tissue is reflected by a large increase in impedance, while during the thawing process the impedance decreases quickly. However, after the freezing-thawing cycle, impedance does not return to the value obtained before freezing, but is consistently lower by about 10%.<sup>2</sup> This impedance drop reflects irreversible changes inside the tissue, highlighting how impedance could be used to assess the quality of cryoablation lesions, as it is for radiofrequency (RF) ablation. Recently, local impedance (LI), measured between mini-electrodes on the catheter tip of a dedicated catheter (IntellaNAV Mifi™ OI; Boston Scientific; equipped with 3 minielectrodes) and the proximal ring, was suggested as a better means of assessing RF lesions,<sup>3</sup> since, when compared to conventional generator impedance, LI has been shown to have a stronger relationship with lesion size both in the atrium and in the ventricle.<sup>3</sup> The LOCALIZE study<sup>4</sup> showed that reaching an  $LI \geq 17$  ohm and  $\geq 14$  ohm in the anterior/superior and posterior/inferior portion of the vein, respectively, is predictive of durable segment block in de novo pulmonary vein (PV) isolation with RF, with a positive predictive value greater than 98%. In this report we aimed to characterize for the first time the substrate modification after cryoballoon ablation through a novel local impedance algorithm.

## Case report

A 51-year-old woman with history of paroxysmal atrial fibrillation and diabetes was referred to our center for PV isolation.

**KEYWORDS** Catheter ablation; Cryoballoon; DirectSense; Local impedance; Tissue lesion  
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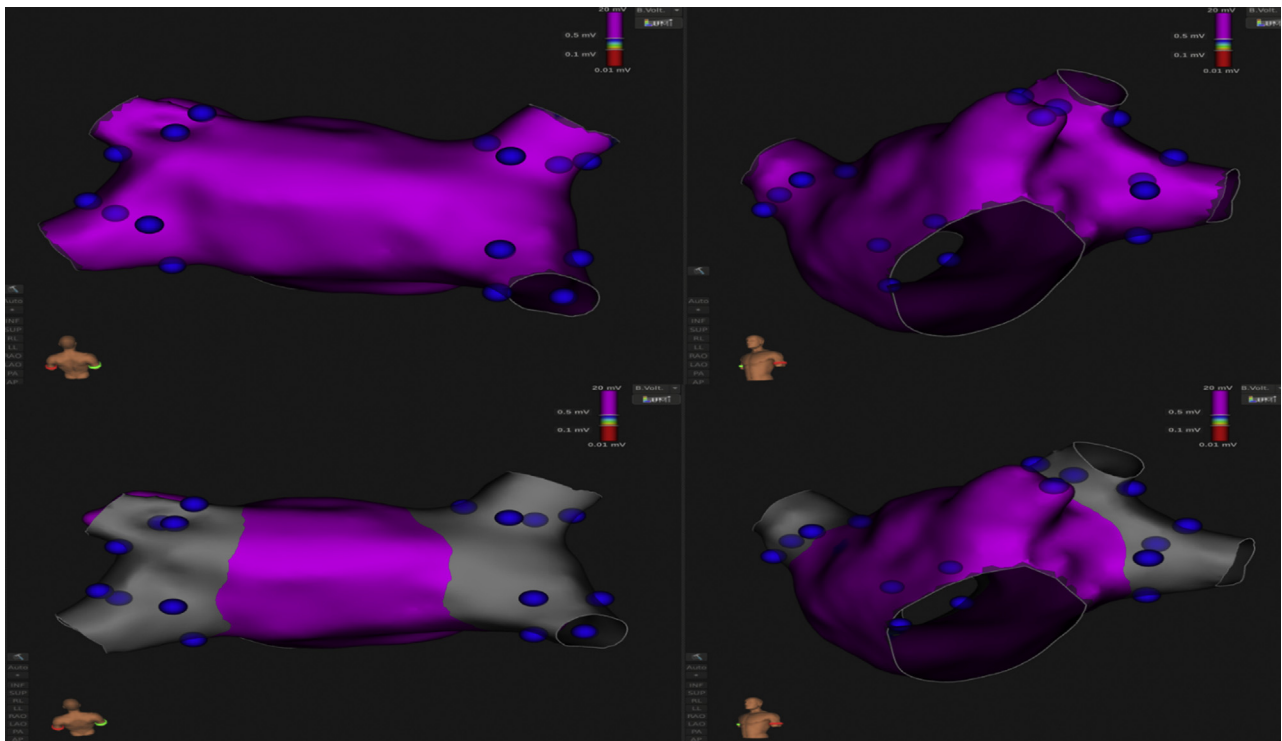
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## KEY TEACHING POINTS

- After ablation, the recorded values of local impedance (LI) were significantly lower than the ones recorded from baseline recordings, showing a large variation in local impedance drop.
- Cryoballoon ablation at pulmonary vein locations resulted in LI drop values comparable to the ones demonstrated at successful radiofrequency ablation spots.
- In this preliminary experience, when conventional predictors of successful cryolesions (eg, time to isolation < 60 seconds) are used to guide cryoablation with this new technology, local impedance drop for each vein and for each segment was greater than 20 ohm.

The procedure was performed with the new POLAR X™ cryoballoon (Boston Scientific, Marlborough, MA) that is designed to provide a more uniform pressure inside the balloon during the inflation and ablation phases in order to minimize balloon dislodgment. The balloon is maneuvered with the help of a tighter bend radius (155°) steerable sheath (POLARSHEATH™) to help access inferior veins. Before cryoablation, a high-density map of the left atrium was carried out with the Rhythmia™ system and the Orion™ catheter (Boston Scientific) while the IntellaNAV Mifi OI catheter was used to assess the LI values of the 4 PVs.

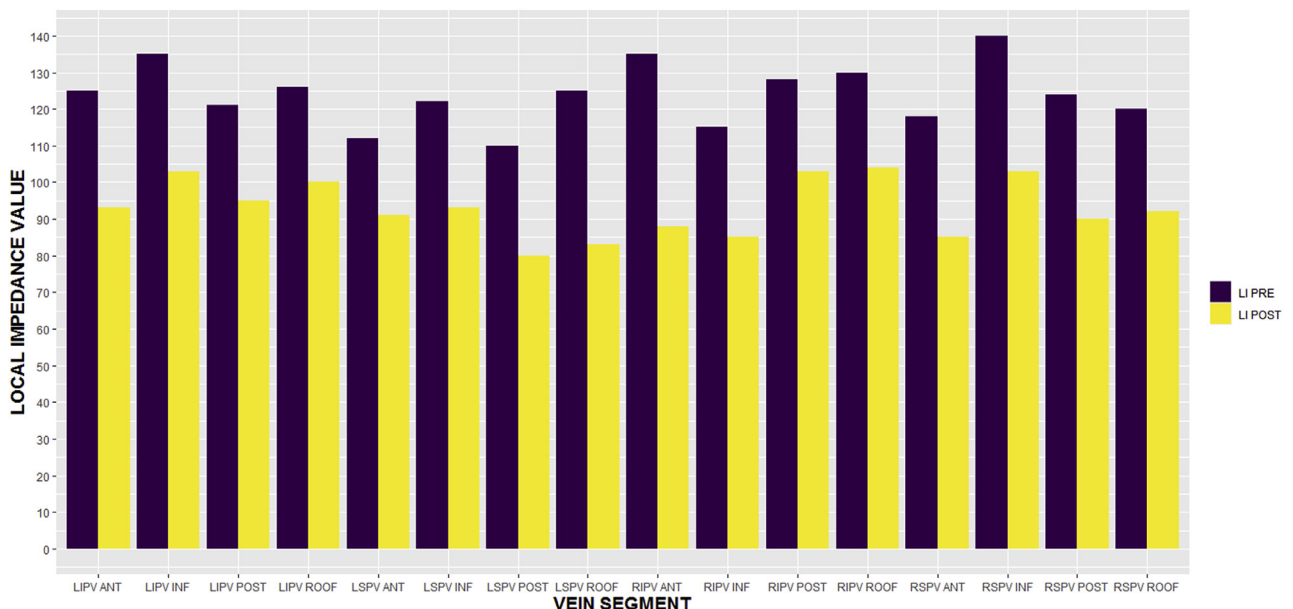
Each vein was divided in 4 segments (anterior, roof, inferior, and posterior) and a manual tag was used to record the exact position where the IntellaNAV catheter measured the LI values for each segment of the vein (Figure 1, Top). All 4 veins were isolated with a time to isolation (TTI) < 60 seconds during each cryoablation with the aid of a small-diameter circular diagnostic catheter (POLARMAP™; Boston Scientific) for monitoring of PV potentials. A single freeze-cycle duration of 180 seconds was applied for each vein, reaching



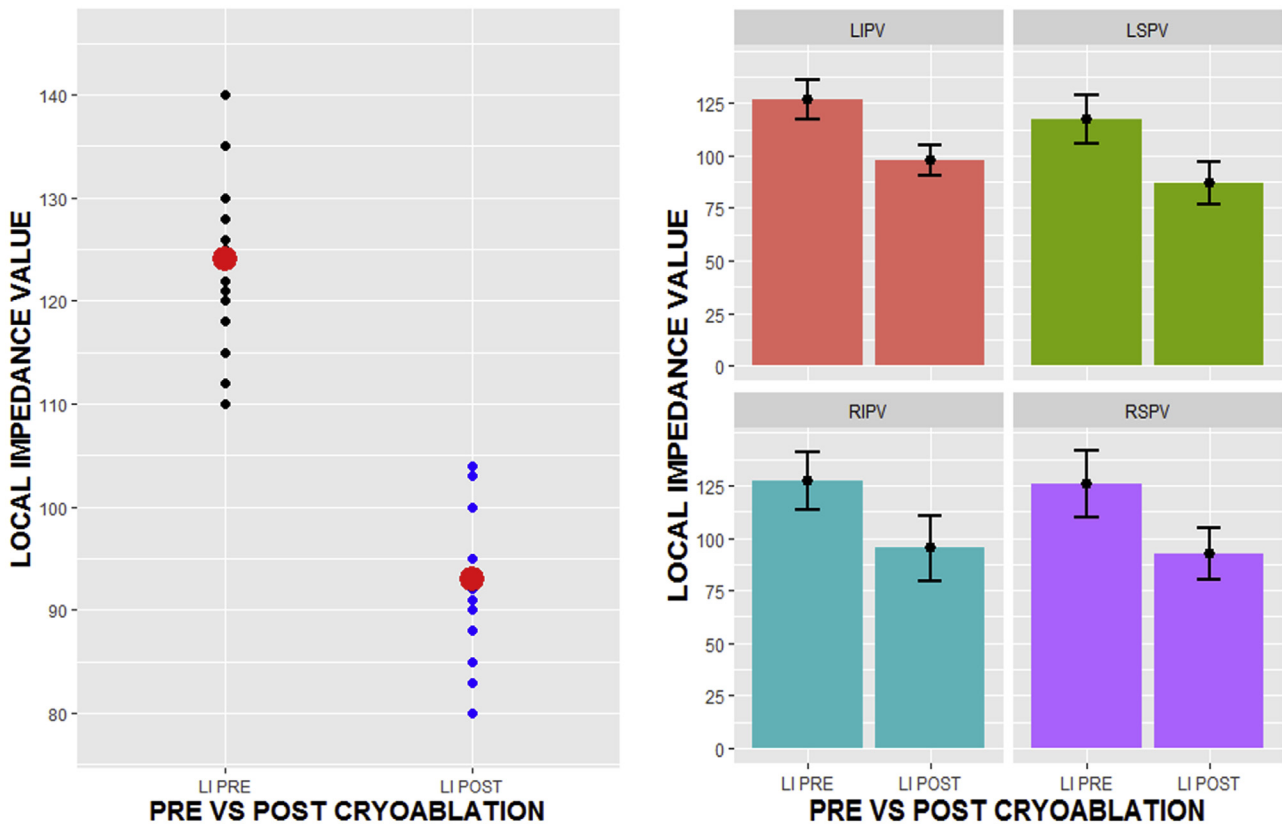
**Figure 1** **Top:** Modified posteroanterior (PA) (left) and left anterior oblique (LAO) (right) view of the left atrial voltage map before cryoablation was undertaken. The blue tags indicate the exact vein segment position where the IntellaNAV™ (Boston Scientific, Marlborough, MA) catheter measured the local impedance (LI) values. **Bottom:** Modified PA (left) and LAO (right) view of the left atrial voltage map after cryoablation. The gray color of the veins shows their electrical disconnection. The same blue tags previously used to take the baseline LI values are now used to record how the LI changed post ablation

a nadir balloon temperature of  $-56^{\circ}\text{C}$ ,  $-60^{\circ}\text{C}$ ,  $-59^{\circ}\text{C}$ , and  $-60^{\circ}\text{C}$  (for the left superior PV, left inferior PV, right superior PV, and right inferior PV, respectively). Throughout the cryoablation of the right-sided PVs, continuous phrenic nerve stimulation pacing was performed at the superior vena cava using a quadripolar diagnostic catheter, and phrenic nerve function

was monitored by utilizing the diaphragmatic movement information provided by the sensor placed on the diaphragm and connected to the SMARTFREEZE™ console. A remap of the left atrium was undertaken with the Rhythmia system and Orion catheter, using the same anatomy acquired before cryoablation had started. The manual tags previously placed



**Figure 2** For each vein segment (anterior, inferior, posterior, roof) the blue bar shows the local impedance (LI) value recorded before ablation while the yellow bar shows the LI value after cryoablation. For each segment and for each vein the LI drop was greater than 17 ohm.



**Figure 3** **Left:** the local impedance (LI) values post ablation (*blue points*) are statistically different from the same values recorded before cryoablation (*black points*). The bold red points represent the mean value of the 2 distributions. **Right:** The height of these colored bars represents the mean LI value for each vein. Each panel compares the LI mean before and after cryoablation for each of the 4 veins. The dark bar on top of each colored bar shows the 95% confidence interval of the LI mean. LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.

at the 4 segments of each vein were used to guide the exact positioning of the IntellaNAV Mifi catheter at the same spots where baseline LI had been recorded in order to record how these values changed after cryoablation. The map confirmed the electrical disconnection of the PVs (Figure 1, Bottom; Supplemental Figure 1, panels A–D). The LI values measured after cryoablation showed that the LI drop for each vein and for each segment was greater than 17 ohm (Figure 2). The recorded values of LI after cryoablation were statistically different from the baseline recordings ( $P < .0001$ , Mann-Whitney test, Figure 3, left panel) and the difference between the average LI before and after ablation were  $30.5 \pm 8.66$  ohm,  $29 \pm 3.46$  ohm,  $33.5 \pm 3.87$  ohm, and  $32.5 \pm 9.81$  ohm for the left superior PV, left inferior PV, right superior PV, and right inferior PV, respectively (Figure 3, right panel).

## Discussion

In this preliminary experience with the new POLAR X cryoballoon, we observed a large variation in LI drop (ie, mean value greater than 20 ohm) when TTI is inferior to 60 seconds and nadir temperature ranges between  $-56^{\circ}\text{C}$  and  $-60^{\circ}\text{C}$  during cryoablation. Previous studies on LI demonstrated

that the magnitude of LI drop is strongly associated with effective ablation sites<sup>5</sup> and predicts durable segment block after RF ablation.<sup>4</sup> Owing to the nature of a single case, we are not able to adequately investigate the possible association of LI characteristics with different ablative technology. However, as LI is a reliable marker of lesion formation, its variation might not be influenced by the energy source at the basis of the lesion itself. Obviously, our findings need to be confirmed through a speculative approach in a larger subset of patients. A future study based on the LI characteristics after cryoablation could help to define the best cryo-dosing protocol for cryoablation.

## Conclusion

This case provides the first antral lesion characterization of a new cryoballoon ablation system in terms of local impedance drop. We observed that, when conventional predictors of successful cryolesions (eg, TTI < 60 seconds) are used to guide cryoablation with this new technology, resulting LI drop values at these sites were comparable to the ones demonstrated at successful RF ablation spots.

## Appendix Supplementary data

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.hrcr.2020.12.007>.

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