# Cryothermal catheter ablation for focal atrial tachycardia originating from the left atrial appendage: The utility and safety of a soft and flexible multispline mapping catheter for the detailed anatomical evaluation

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## Introduction

Focal atrial tachycardia (AT) originating from the left atrial appendage (LAA) is relatively infrequent.[1–3] Although radiofrequency catheter ablation is effective for AT originating from the LAA, anatomical features of the LAA, such as thick pectinate muscle bands and a thin-walled myocardium,[4] present challenges, sometimes requiring epicardial ablation,[5] a combined endocardial and epicardial approach,[6,7] or surgical resection of the LAA.[4] An alternative approach is cryothermal catheter ablation,[8] although its use is not widely documented.

Here, we describe 2 cases in which cryothermal catheter ablation, preceded by a detailed anatomical evaluation of the LAA using a multielectrode mapping catheter, achieved successful outcomes.

## KEY TEACHING POINTS

- Focal atrial tachycardia (AT) originating from the left atrial appendage (LAA) is rare, and conventional radiofrequency ablation approaches are challenging.
- We present 2 cases of patients with AT originating from the LAA in which cryothermal catheter ablation was successfully applied.
- In both cases, detailed anatomical evaluation using multielectrode mapping was important for guiding treatment.

## Case report

### Case 1

A 46-year-old man without structural heart disease presented with recurrent AT (Figure 1A). He had previously undergone unsuccessful radiofrequency catheter ablation for AT originating from the LAA (Figure 1B) at another hospital 4 years prior. During the second procedure at our hospital, an activation map created using a multispline mapping catheter (PentaRay; Biosense Webster Inc, Irvine, CA) revealed the earliest activation site (EAS) at the distal posterior lobe of the LAA (Figure 1C). The LAA had 2 lobes, as demonstrated on 3-dimensional computer tomography (Figure 1D), and a distal tip electrode equipped with PentaRay allowed the mapping of the distal tip of the LAA (Figure 1E and 1F). A multielectrode circular catheter (Lasso; Biosense Webster Inc) was positioned near the EAS for anatomical reference and radiography confirmed that the EAS was located in the LAA (Figure 1G). Considering the thin wall of the LAA and the risk of cardiac perforation, cryothermal ablation (-80°C, 90 seconds) was performed using an 8-mm-tip catheter (Freezor MAX; Medtronic Inc, Minneapolis, MN). The Freezor MAX was manipulated under fluoroscopic guidance, and the local

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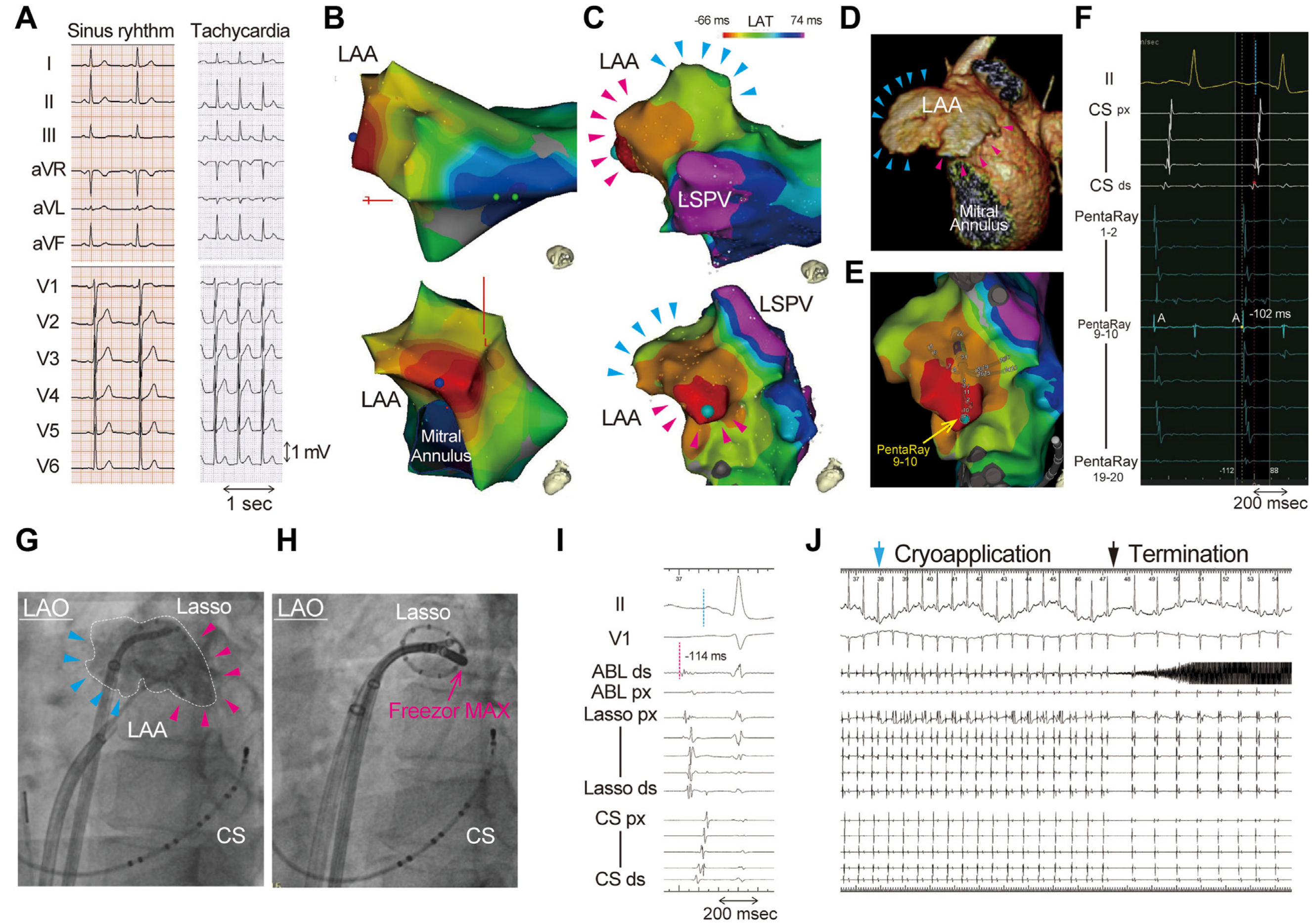


**Figure 1** Presentation of case 1. **A:** Left panel: Sinus rhythm with a heart rate of 67 beats/minute. Right panel: Atrial tachycardia (AT) with a heart rate of 130 beats/minute. **B:** Activation map of AT using a conventional 3.5-mm-tip catheter during the first procedure performed in another hospital. The earliest activation site (EAS) was the left atrial appendage (LAA). **C:** Activation map of the AT using a multispline mapping catheter (PentaRay; Biosense Webster Inc, Irvine, CA) in the second procedure. The LAA has 2 distinct lobes; the cyan and magenta triangles indicate the anterior and lateral lobes, respectively. The EAS is the tip of the lateral lobe (*blue tag*). **D:** Three-dimensional computed tomography image showing 2 distinct lobes, as shown in panel C. **E:** A tip electrode equipped with PentaRay catheter (*yellow arrow*) allowed the mapping of the distal tip of the LAA, which is the EAS of AT. **F:** At the EAS, local electrogram (*yellow point*) 102 ms preceding the onset of the P wave (*blue dotted line*). **G:** Radiography shows 2 distinct lobes, as shown in panels C and D. A circular catheter (Lasso; Biosense Webster Inc) was used as a reference. **H:** An 8-mm-tip cryothermal catheter (Freezor MAX; Medtronic, Minneapolis, MN) was positioned at the EAS within the LAA. **I:** Local electrogram (*magenta dotted line*) before cryoablation shows 114 ms preceding the onset of the P wave (*blue dotted line*). **J:** AT terminated 9 seconds after starting the cryoapplication. CS = coronary sinus; ds = distal; LAO = left anterior oblique; LSPV = left superior pulmonary vein; px = proximal.

electrogram was confirmed to be earlier than the Lasso (Figure 1H and 1I). Within 9 seconds of application, AT slowed and was converted to a sinus rhythm (Figure 1J). AT was no longer induced after 7 additional applications (each 90 seconds). Major complications, including phrenic nerve injury, were not observed. The patient remained free from AT 4 years after the procedure.

## Case 2

A 14-year-old girl presented to our hospital with palpitations. Electrocardiography showed tachycardia (Figure 2A), and 24-hour Holter electrocardiogram showed persistent tachycardia. She was diagnosed with heart failure, with a reduced left ventricular ejection fraction of 35%, necessitating hospitalization for catheter ablation. Electrophysiological studies confirmed the presence of AT. An activation map obtained using a multispline mapping catheter (OctaRay; Biosense Webster Inc) showed a centrifugal pattern from the base of the LAA (Figure 2B–2D). Initial cryothermal ablation (-80°C, 240 seconds) using a 6-mm-tip catheter (Freezor Xtra; Medtronic Inc) slowed the AT and restored sinus rhythm; however, the AT recurred (Figure 2E). Pilsicainide (150 mg/d) temporarily suppressed AT, which relapsed after 2 months. In the subsequent procedure, OctaRay was positioned at the LAA for anatomical reference (Figure 2F). The Freezor MAX was manipulated under fluoroscopic guidance, and the local electrogram was confirmed to be earlier than the OctaRay; thereafter, cryothermal ablation (-80°C, 240 seconds) using an 8-mm-tip catheter (Freezor MAX, Medtronic Inc) successfully abolished the AT (Figure 2G–2I), without any complications, including phrenic nerve injury. Three months after the second procedure, the patient was free from AT, and left ventricular ejection fraction was restored to the normal range.

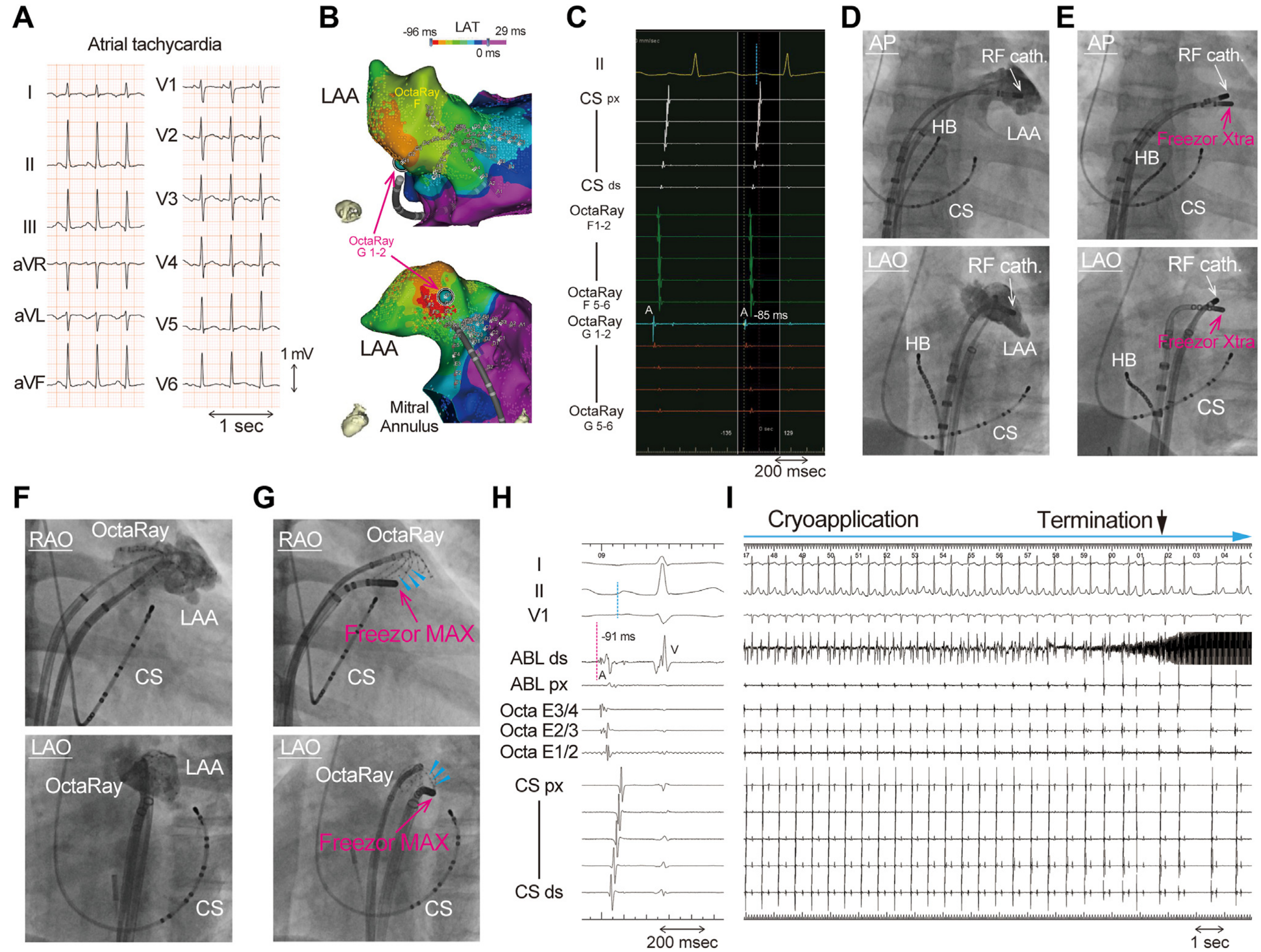


**Figure 2** Presentation of case 2. **A:** Atrial tachycardia (AT) with a heart rate of 139 beats/minute. **B:** Activation map of the AT using a multispline mapping catheter (OctaRay; Biosense Webster Inc, Irvine, CA). The base of the left atrial appendage (LAA) is the earliest activation site (EAS) (*blue tag*). **C:** At the EAS, local electrogram (*yellow point*) 85 ms preceding the onset of the P wave (*blue dotted line*). **D:** Radiography of the LAA during the first procedure. The 3.5-mm-tip ablation catheter was positioned as a reference. **E:** Cryoablation using a 6-mm-tip cryothermal catheter (Freezor Xtra; Medtronic Inc, Minneapolis, MN) was applied at the EAS within the LAA (first procedure). **F:** Radiography of the LAA during the second procedure. OctaRay was used as a reference. **G:** Cryoablation using an 8-mm-tip cryothermal catheter (Freezor MAX; Medtronic Inc) applied at the EAS within the LAA (second procedure). Cyan triangles indicate the earliest splines. **H:** Local electrogram (*magenta dotted line*) at the EAS 91 ms preceding the onset of the P wave (*blue dotted line*) and the earliest spline of OctaRay (*cyan triangles* in panel F). **I:** AT terminated 22.6 seconds after starting the cryoapplication. AP = anterior-posterior; HB = His bundle; RAO = right anterior oblique; RF cath = radiofrequency catheter; other abbreviations as in Figure 1.

## Discussion

This case report highlights 2 key points: the effectiveness of cryothermal catheter ablation for AT originating from the LAA and the utility and safety of a soft and flexible multispline mapping catheter for the detailed anatomical evaluation.

Cryothermal catheter ablation successfully abolished AT originating from the LAA in 2 patients. The LAA is a rare source of focal AT, and radiofrequency catheter ablation has been reported to be helpful.[1–3] However, this approach is sometimes challenging owing to the anatomical features of the LAA. A very thin-walled myocardium of the LAA may be prone to perforation, and cardiac tamponade occurred in 1.8% of patients who undergo LAA isolation by radiofrequency catheter ablation as an additional procedure for atrial fibrillation ablation.[9] Some cases require epicardial ablation[4] or a combination of endocardial and epicardial approaches,[6,7] suggesting that a thick pectinate muscle may preclude lesion formation. In this context, creating a transmural lesion in a beating heart by maintaining contact force while avoiding perforation is difficult for patients who undergo surgical resection of the LAA after failed radiofrequency catheter ablation.[4] Freeze-mediated catheter adhesion to the tissue in cryothermal catheter ablation may have an advantage at sites where it is difficult to maintain catheter stability with avoidance of perforation, such as the atrial appendage. Our cases demonstrate that cryothermal catheter ablation is a valuable and less invasive alternative to the epicardial approach or surgical resection.

Our cases highlighted the significance of conducting a detailed anatomical evaluation using a multispline mapping catheter. In case 1, the AT originated from the tip of the lateral lobe of the LAA. As shown in Figure 1B, 1C, and 1E, a soft and flexible multispline catheter (PentaRay) allows detailed electroanatomical mapping of the LAA, capturing its 2 distinct lobes. Basket or fixed electrode array catheter structures are employed for electroanatomical mapping; however, they lack electrodes at the catheter tips. Given the complex structure of the LAA, and the occasional importance of mapping its distal tip,[1,2] soft and flexible multispline catheters equipped with tip electrodes appear to be more effective. Epicardial approach or cryothermal catheter ablation is an alternative strategy if endocardial radiofrequency ablation is ineffective for AT originating from the LAA. Although surgical resection is the last resort, evaluating the detailed morphology and the source of the AT using a multispline mapping catheter is essential to elucidate the resection area (lobes or tip/mid/base).

We postulated that a large cryothermal catheter would be effective for treating AT originating from the LAA. In case 2, a second procedure was required. For the first procedure, we chose a 6-mm-tip catheter (7F) based on the required sheath size. The lesion volume was smaller in the smaller-tip cryothermal catheter.[10] The origin of AT may be intramural or epicardial, requiring epicardial or both endocardial and epicardial approaches.[5–7] In case 2, a small-tip catheter may have been insufficient to create an effective lesion for AT owing to its deep arrhythmic focus. Although the 2 cases of AT originating from LAA treated using a 4-mm-tip cryothermal catheter have been reported,[8] further research is required to address this issue. There are several potential alternative approaches for extending the lesion creation. Pulsed field ablation may overcome the creation of transmural lesions,[11] even though the remaining concern is perforation. Cryoablation using simultaneous multicatheter is reported in left atrial non–pulmonary vein substrate ablation[12] or resistant accessory pathway.[13] LAA isolation might be an alternative strategy; however, its role is limited by low durability (ie, 78.3% in radiofrequency ablation and 66.0% in cryoballoon ablation)[14] and increased risk of stroke.[15]

## Conclusion

Cryothermal ablation using an 8-mm-tip catheter proved to be a safe and effective treatment for AT originating from the LAA. Detailed electroanatomical mapping of the LAA morphology using a multispline mapping catheter was instrumental in achieving successful outcomes.

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