Cavotricuspid Isthmus Conduction Split by Pouch-Like Recesses During Typical Atrial Flutter

Yasushi Oginosawa, MD; Akihiko Nogami, MD; Kenji Kurosaki, MD; Aiko Sugiyasu, MD; Shoichi Kubota, MD; Shinya Kowase, MD; Tetsuo Yamasaki, MD; Shiho Takada, MD; Jun Suzuki, MD; Mihoko Sakamaki, MD; Hajime Aoki, MD; Kazuhiko Yumoto, MD; Toshiyuki Tamaki, MD; Kenichi Kato, MD

A 58-year-old man had typical cavotricuspid-isthmus-dependent atrial flutter (AFL). Right atrial angiography and multidetector computed tomography revealed a deep pouch-like recess in the mid-isthmus region. Linear ablation from the pouch to the edge of the inferior vena cava resulted in widely split double potentials without any change in the AFL cycle length. This observation suggested that the pouch played an electrophysiological role by dividing the flutter wavefront into 2 parallel conduction wave fronts through both sides of the pouch along the isthmus during typical AFL. When a widely split potential is created on 1 side of the pouch, the other side of the pouch should be targeted. (Circ J 2009; 73: 179–182)

Key Words: Atrial flutter; Catheter ablation; Cavotricuspid isthmus; Double potential; Pouch-like recess

Radiofrequency catheter ablation (RFCA) of the cavotricuspid isthmus has been established as the first-line therapy for isthmus-dependent typical orthodromic atrial flutter (AFL)1–3. Although RFCA of AFL has had a high success rate, the creation of a bidirectional isthmus conduction block may be difficult in some patients4–6 and one of the main reasons for the difficulty is that the anatomical structure of the isthmus is complex and highly variable, including having pouch-like recesses6–9. In addition, the relationship between the anatomy and details of the propagation of the flutter waves within the isthmus remains obscure.

We present a case of typical AFL with a deep pouch-like recess detected by multidetector computed tomography (MD-CT) in which there were widely split double potentials without any change in the AFL cycle length after linear ablation from the pouch in the isthmus to the edge of the inferior vena cava (IVC).

Case Report

A 58-year-old man was referred for ablation of drug-refractory symptomatic AFL. The 12-lead ECG revealed a typical orthodromic AFL with a 4:1 ventricular response (Fig 1A). In the baseline electrophysiological study, the activation sequence indicated typical counterclockwise AFL around the tricuspid annulus (TVA). The AFL cycle length was 220 ms (Fig 2A). When we attempted to position the ablation catheter on the cavotricuspid isthmus in order to perform a linear ablation, the tip got caught in the middle of the isthmus. Right atrial angiography revealed a deep pouch-like recess at that position (Fig 3A). After a point-by-point linear ablation from the pouch to the edge of the IVC (Fig 3A), very widely split double potentials (Fig 2B) were recorded without any significant change in the 12-lead ECG (Fig 1B). At the ablation site to the coronary sinus (CS) ostium revealed U-turn activation (Fig 4C). Single atrial potentials were recorded along the isthmus between the TVA and pouch (Fig 2C), and an entrainment study from that site revealed entrainment with a post-pacing interval equal to the flutter cycle length. Additional ablation applications along the area from the TVA to the pouch terminated the AFL and the bidirectional isthmus conduction block was completed. Afterwards, MD-CT scanning revealed a deep and long pouch-like recess in the mid-isthmus region (Figs 3B, C).

Discussion

Pouch-like recesses are deep pockets that are located traversing the central cavotricuspid isthmus and anterior portion of the Eustachian valve. Although these pouches in the isthmus are usually considered as major obstacles during the ablation procedure for AFL,10 the electrophysiological role of those pouch-like recesses is not well understood.

Cabrera et al performed an angiographic and histological study of isthmuses in patients with and without AFL. The size of the inferior isthmus and pouch-like recess in the patients with typical AFL was significantly larger than in the control. They also reported that the posterior side of the pouch was membranous and lacked any atrial myocardium, and that the inferior side of the isthmus was trabeculated and consisted of longitudinal or obliquely arranged bundles of atrial myocardium separated by connective tissue in 77% of specimens. Waki et al10 also reported that 16% of their 50 autopsy series exhibited a membranous large muscular
Fig 1. Comparison of the 12-lead ECG (A) before and (B) after catheter ablation from the pouch to the inferior vena cava. There was no substantial change.

Fig 2. Surface ECG leads II, aVR and V1 and intracardiac electrograms. A 20-pole catheter was placed along the tricuspid annulus (TVA) with its distal electrode pair (Halo 1–2) positioned in the low lateral right atrium. The ablation catheter (Abl) was positioned at the cavotricuspid isthmus. (A) Before ablation, the atrial flutter (AFL) cycle length was 220 ms. (B) After the ablation, widely split double potentials from the pouch to the inferior vena cava were recorded along the posterior isthmus by the Abl. There was no change in the AFL cycle length. (Arrow) Second potential. (C) After the ablation, the single atrial potentials were recorded along the isthmus between the TVA and pouch. An entrainment study from that site revealed concealed entrainment with a post-pacing interval equal to the flutter cycle length.
Fig 3. (A) Angiogram of the right atrium (RA) in the right anterior oblique view. (B) Vertical long-axis view and (C) horizontal long-axis view of multidetector computed tomography scans. A deep and long pouch-like recess can be observed in the mid-isthmus. The length of the isthmus was estimated to be over 40 mm. RV, right ventricle; CS, coronary sinus.

Fig 4. Hypothetical schematic of the cavotricuspid isthmus conduction before and after the ablation between the pouch-like recess and inferior vena cava (IVC), which explains the widely split double potentials recorded by the ablation catheter (Abl) from the pouch-like recess to the IVC. (A) Before the ablation, the pouch split the wave front of the atrial flutter (AFL) into parallel anterior and posterior conduction bundles. (B) After the ablation, the ablation line blocked the posterior conduction, resulting in U-turn activation from the anterior isthmus to the blind loop. The cycle length of the AFL did not change because the leading wave front of the AFL traveled along the anterior isthmus. (C) Mapping from the ablation site to the coronary sinus (CS) ostium. Because the second potential of the double potentials was recorded after atrial activation at the CS ostium, the second potential was a bystander and not part of the AFL circuit.
defect between the anterior and posterior muscular trabeculae in the cavotricuspid isthmus. These findings suggest that a portion of the pouch may be an anatomic nonconducting structure located in the isthmus.

There have been several reports on the parallel conduction of flutter waves in the isthmus. Takahashi et al. performed a sequential withdrawal mapping study in the isthmus from the TVA to the IVC in 30 patients with AFL before ablation. Double potentials separated by an isoelectric interval resulting from partial isthmus block were recorded in 11 patients, and were recorded from the mid-isthmus to the edge of the IVC in 10 and the edge of the TVA in the remaining patient. Because the second potential of the double potentials was recorded after atrial activation at the CS ostium, the second potential was a bystander and not part of the AFL circuit. Iesaka et al. investigated the influence of the segmental ablation of the IVC-TVA isthmus in 40 patients, 7 of whom exhibited a sudden prolongation of the flutter cycle length with the segmental ablation of the anterior side of the isthmus. This jump-up phenomenon indicates that the IVC-TVA isthmus may contain dual circumferential muscle bundles. The observation in the present case suggests that the electrophysiological role played by the pouch was that it split the conduction of the anterior side of the isthmus during typical AFL. The creation of a block line between the pouch and edge of the IVC resulted in a blind loop and U-turn activation, the antidromic wavefront went into a blind loop, dead-end pathway with widely split double potentials (Fig. 4B).

It is well known that the length and morphology of the cavotricuspid isthmus correlates with the difficulty in achieving bidirectional isthmus block by RFCA. In patients with a complex anatomy of the cavotricuspid isthmus, imaging modalities, such as angiography, intracardiac echocardiography, or 3D-mapping systems are helpful for achieving successful RFCA. MD-CT or MRI may be also worth considering in patients with prior failed ablation procedures in order to identify before reoperation whether or not this abnormality exists. And when a widely split potential is created on 1 side of the pouch, the other side of the pouch should be targeted.

**Conclusion**

In some patients with typical AFL with pouch-like recesses in the cavotricuspid isthmus, the pouch plays an electrophysiological role by splitting the flutter wave front into parallel conduction wave fronts along both sides of the pouch through the isthmus.

---

**References**


