Single-catheter validation of bidirectional block during atrial flutter ablation

Piotr Futyma, MD,* Marian Futyma, MD, PhD,* Konrad Dudek, MD,* Piotr Kułakowski, MD, PhD, FESC†

From the *Invasive Cardiology Department, St Joseph’s Heart Centre, Rzeszow, Poland, and †Department of Cardiology, Postgraduate Medical School, Grochowski Hospital, Warsaw, Poland.

Introduction
Radiofrequency catheter ablation (RFCA) of typical atrial flutter (AFL) is an effective and widely performed method of treatment. Confirmation of conduction block in the cavo-tricuspid isthmus (CTI) is the best endpoint of the procedure.1–3 Electrophysiological measurements for validation of CTI block are usually performed using 2 or 3 catheters. However, in some situations this multi-catheter approach may not be possible or is associated with increased peri-procedural risk.4–7 In such cases, the already implanted permanent pacemaker may be used to perform electrophysiological maneuvers. We present a case report of RFCA of AFL performed with a single-catheter set and acute electrophysiological success confirmation.

Case report
A 61-year-old woman with a dual-chamber pacemaker (PM) was referred for RFCA owing to recurrent typical AFL. Because of massive leg varices, problems with femoral vein access, and increased risk of peri-procedural deep vein thrombosis, a single-catheter procedure was undertaken. Pacing using PM leads was performed before and after ablation in order to confirm block in the CTI. Before RFCA, the PM was programmed to VVI 90/min mode—retrograde conduction via the atrioventricular node (AVN) was confirmed, with activation on the ablation catheter located at the tricuspid annulus (TA) suggesting conduction via CTI, with the distance from the ventricular pacing signal to low right atrium of 136 msec, and with the absence of atrial double potentials in the CTI. After completing the CTI ablation line, the distance between ventricular paced signal to low right atrium increased to 197 msec and the reversed activation pattern on ablation catheter confirmed CTI block in the clockwise direction (Figure 1). Moreover, double potentials (AA'—101 msec) were recorded at the ablation line (Figure 2). The conduction block through CTI in the counterclockwise direction was further documented by differential pacing from the ablation catheter positioned at the TA and measuring the distance to ventricular activation occurring through the AVN (Figure 3). The patient was discharged home the next day and continues to be free of symptoms 6 months after the procedure.

Discussion
Clockwise CTI block is usually confirmed by measurements on the TA and in CTI during coronary sinus pacing. Alternatively, when intact retrograde conduction through the AVN is present, acute success may be validated during ventricular pacing, as was shown during invasive electrophysiological studies.8,9 Our report suggests that in patients with PM and present retrograde ventriculoatrial conduction, successful RFCA of AFL with confirmation of conduction block through CTI can be achieved using only 1 ablation catheter. Measurements obtained from the ablation catheter and using various PM programming demonstrated RFCA-induced conduction block in the CTI in the clockwise direction, whereas separation of atrial potentials by 101 msec suggests the presence of true bidirectional block.10 The conduction block through the CTI in the counterclockwise direction can be further documented by differential pacing using a single-ablation catheter only, positioned at the TA and measuring the distance between paced A signal and ventricular activation occurring through the AVN,11 as was done in this case (205–225 msec).

KEYWORDS Catheter ablation; Atrial flutter; Noninvasive programmed stimulation

ABBREVIATIONS AFL = atrial flutter; AVN = atrioventricular node; CTI = cavo-tricuspid isthmus; PM = pacemaker; RFCA = radiofrequency catheter ablation; TA = tricuspid annulus

Address reprint requests and correspondence: Piotr Futyma, St Joseph’s Heart Centre, Invasive Cardiology Department, Anny Jagiellonki 17, 35-623 Rzeszów, Poland. E-mail address: piotr.futyma@gmail.com.
The concept of single-catheter CTI block confirmation has a few limitations. Firstly, it requires preserved retrograde ventriculoatrial conduction. Secondly, a patient has to be in sinus rhythm from the beginning of the procedure. Other possibilities of assessing CTI block include the use of an atrial PM lead for pacing when it is located near the coronary sinus (or anywhere on the “septal” side of the ablation line) or use of a superior venous approach to introduce the diagnostic catheter. To our knowledge this is the first case report showing the usefulness of a permanent PM in confirming CTI block, which enables a single-catheter approach to cure typical AFL in patients with PM.

KEY TEACHING POINTS

• Atrial flutter can be effectively cured by ablation and bidirectional block in the cavotricuspid isthmus (CTI), usually evaluated using 2 or more electrodes, is mandatory to confirm the effectiveness of ablation. However, a multi-catheter approach sometimes may not be possible, or may increase risk of procedure-related complications.

• In patients with an already implanted pacemaker only 1 ablation electrode is enough to demonstrate the CTI block.

• Intact retrograde conduction is mandatory to validate CTI block in the clockwise direction with the presented technique.

Figure 1  Right panels show intracardiac electrograms from the distal (Map D) and proximal (Map P) tip of the ablation catheter and surface electrocardiogram lead III. Left panels show fluoroscopic images of the right atrium in the left lateral oblique projection (45 degrees) showing 2 permanent pacemaker leads in the right ventricle and in the right atrium, ablation electrode, with superimposed arrows showing direction of depolarization wave, important structures, and site of block (zig-zag arrow). A: Before ablation during pacing from the ventricular pacing lead, atrial electrogram is earlier in Map D than in Map P because there is no block in the cavotricuspid isthmus (CTI), the distance from septum to ablation electrode tip is shorter through the CTI than along the tricuspid annulus in the counterclockwise direction, and therefore the impulse first reaches Map D and later Map P. B: After ablation the CTI block is created and the impulse travels along the tricuspid annulus, first reaching Map P and later Map D. Thus, CTI block in the clockwise direction is documented. AVN = atrioventricular node; PS = pacing site (pacemaker ventricular lead).
Figure 2  Right panel shows intracardiac electrograms from the ablation electrode before (A) and after (B) creating cavitricuspid isthmus (CTI) block. 

A: Before ablation there is a single atrial signal (SP = single potential) because the activation wavefront approaches the tip of the ablation electrode only from 1 side.

B: After creation of the CTI block, the impulse reaches the CTI first from the septal side, and after 101 msec from the other side of the block, resulting in 2 split atrial potentials (DP = double potentials). Thus, the CTI block in the clockwise direction is documented and strongly suggest true bidirectional block. 

Abbreviations as in Figure 1.
Conclusion
A single-catheter approach to cure typical AFL is feasible in patients with PM and intact retrograde ventriculoatrial conduction.

References
1. Shah DC, Haissaguerre M, Jais P, Clementy J. Atrial flutter: contemporary electrophysiology and catheter ablation. PACE 1999;22:344–359.
2. Shah DC, Takahashi A, Jais P, Hocini M, Clementy J, Haissaguerre M. Local electrogram based criteria of cavotricuspid isthmus block. J Cardiovasc Electrophysiol 1999;10:662–669.
3. Chen J, de Chillou C, Basiouny T, Sadoul N, Da Silva Filho J, Magnin-Poull I, Messier M, Aliot E. Cavotricuspid isthmus mapping to assess bidirectional block during common atrial flutter radiofrequency ablation. Circulation 1999;100:2507–2513.
4. Alizadeh A, Rad MA, Moradi M, Emkanjoo Z. Predictors of local venous complications resulting from electrophysiological procedures. Cardiol J 2012;19:15–19.
5. Chen SA, Chiang CE, Tai CT, Cheng CC, Chiou CW, Lee SH, Ueng KC, Wen ZC, Chung MS. Complications of diagnostic electrophysiologic studies and radiofrequency catheter ablation in patients with tachyarrhythmias: an eight-year survey of 3,966 consecutive procedures in a tertiary referral center. Am J Cardiol 1996;77:41–46.
6. Hung CY, Lin TC, Hsieh YC, Lee WL, Huang JL, Chang WC, Ting CT, Wu TJ. Acute massive pulmonary embolism after radiofrequency catheter ablation: a rare complication after a common procedure. J Chin Med Assoc 2012;75:409–412.
7. Kagawa Y, Fujii E, Fujita S, Omura T, Ito M. Radiofrequency ablation of common atrial flutter via right subclavian/jugular vein access in a patient with bilateral lower limb venous obstruction: importance of contact force monitoring during mapping and ablation. Heart Rhythm Case Rep. 10.1016/j.hrcr.2015.08.004.2015.08.
8. Vijayaraman P, Kok LC, Wood MA, Ellenbogen KA. Right ventricular pacing to assess transisthmus conduction in patients undergoing isthmus-dependent atrial flutter ablation: a new useful technique? Heart Rhythm 2006;3:266–272.
9. Miracapillo G, Costoli A, Addonizio L, Breschi M, Severi S. Can right ventricular pacing be useful in the assessment of cavo-tricuspid isthmus block? Indian Pacing Electrophysiol J 2008;8:247–257.
10. Scaglione M, Caponi D, Riccardi R, Maines M, Di Donna P, Bocchiardo M, Rossi P, Sartori G, Gaia F, Chierchìa S. Local electrogram assessment of unidirectional isthmus block is sufficient to predict the acute and long term success of cavo-tricuspid isthmus ablation. Ital Heart J 2002;3:263–269.
11. Klug D, Lacroix D, Marqué C, Maressé G, Aïx D, Dennevirle S, d’Hautefeuille B, Zghal N, Kacet S. Prospective evaluation of a simplified approach for common atrial flutter radio frequency ablation with only two catheters. Europace 2001;3:208–215.