Right and Left Atrial Macroreentrant Tachycardias

Shih-Lin Chang, MD, PhD, Shih-Ann Chen, MD*

KEYWORDS

• ECG • Macroreentrant tachycardias • Atrial flutter • Circuit • Mapping • Algorithm

KEY POINTS

- A 12-lead electrocardiogram (ECG) during tachycardia provides important information in the initial strategy for the physician or specialized cardiologist.
- Catheter ablation of the cavotricuspid isthmus can eradicate typical and reverse typical atrial flutter (AFL) with a high success rate and few complications.
- For atypical AFL, catheter ablation of the isthmus between the boundaries using electroanatomic mapping can eliminate these arrhythmias.

Atrial macroreentrant tachycardia is a common tachycardia in clinical practice and its incidence is increasing because of the aging population.[1–6] It can result from structural heart disease or scarring from previous cardiac surgery/ablation but also can be found in patients without obvious heart disease.[2,3,7] Macroreentrant atrial tachycardia is characterized by an atrial tachycardia driven by a large reentry circuit around a central obstacle with fixed and/or functional barriers.[8] Entrainment is possible in most macroreentrant atrial tachycardias. Numerous forms of macroreentrant atrial tachycardia have been reported, and the surface electrocardiogram (ECG) patterns could correlate with the reentrant circuits. Atrial flutter (AFL) is defined by an undulating F wave in the ECG with a sawtooth appearance, which represents macroreentrant atrial tachycardia in surface ECG. Therefore, the 12-lead ECG provides important information for the location of the reentrant circuit location and mechanism.

It is crucial to understand how to determine a macroreentrant tachycardia origin based on the 12-lead ECG morphology of the flutter wave. A period of at least 3:1 AV block during tachycardias is suitable for flutter wave analysis. The widest flutter wave of any lead is used to define the onset and the offset of flutter wave in all other leads.[9] The schemas of variable flutter wave morphologies on 12-lead ECGs are shown in Fig. 1.

ELECTROPHYSIOLOGY STUDY AND ECG CHARACTERISTICS OF MACROREENTRANT TACHYCARDIAS

Typical and Reverse Typical AFL

Typical AFL is the most common type of macroreentrant atrial tachycardia, even in patients with prior cardiac surgery/ablation.[8,10] The cavotricuspid isthmus (CTI), defined as a path bounded by the orifice of the inferior vena cava, eustachian valve/ridge, coronary sinus ostium, and tricuspid annulus, is a protected zone of slow conduction during typical AFL.[7] Activation mapping has shown that the activation wave front goes downward in the right atrial (RA) free wall, travels

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Department of Medicine, Taipei Veterans General Hospital, 201 Section 2, Shih-Pai Road, Taipei, Taiwan
* Corresponding author.
E-mail address: epsachen@ms41.hinet.net

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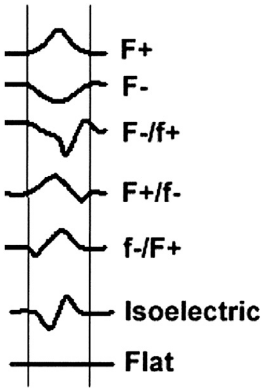

Fig. 1. The schemas of variable flutter wave morphologies on 12-lead ECGs. The first 2 waves are monophasic positive (F+) and negative (F−) flutter waves. The third to sixth waves are biphasic flutter waves, consisting of dominant negative with small terminal positive (F−/f+), dominant positive with small terminal negative (F+/f−), small initial negative with dominant terminal positive (f−/F+), and the equal amplitude of negative and positive waves (isoelectric). Flat polarity is amplitude less than 0.01 mV and more than −0.01 mV. (*From* Yuniadi Y, Tai CT, Lee KT, et al. A new electrocardiographic algorithm to differentiate upper loop re-entry from reverse typical atrial flutter. J Am Coll Cardiol 2005;46:525; with permission.)

through the CTI, spreads upward in the septal wall, and crosses the crista terminalis to complete the reentrant circuit (Fig. 2). Reverse slow conduction and rate-dependent conduction delay in the CTI is mechanistically important for the development of typical AFL (Fig. 3). The activation sequence of reverse typical AFL is the opposite of typical AFL.

Slow conduction in the CTI may be mechanistically important for the development of typical and reverse AFL (CTI-dependent AFL). The tricuspid annulus is the anterior and fixed barrier. The crista terminalis and eustachian ridge form the posterior barrier in typical AFL. Split potentials can be recorded along the length of the crista terminalis during pacing from the low posterior right atrium at a long cycle length in patients with clinical AFL, suggesting that poor transverse conduction property in the crista terminalis may be the requisite substrate for the clinical occurrence of typical AFL.[11]

Typical AFL has positive F waves in lead V1; negative F waves in lead V6; and negative F waves in leads II, III, and aVF.[8] Low-amplitude flutter waves can be seen in leads I and aVL (Fig. 4A). Reverse typical AFL has wide, negative P waves in lead V1; positive P waves in lead V6; and broad, positive P waves in leads II, III, and aVF (see Fig. 4B).[12] However, it may present with different ECG patterns that need activation mapping to define the exact circuit.

RA Upper Loop Reentry and Lower Loop Reentry

Atypical RA flutters could arise from single-loop or double-loop figure-of-eight reentry.[13,14] The activation wave front circulates around the

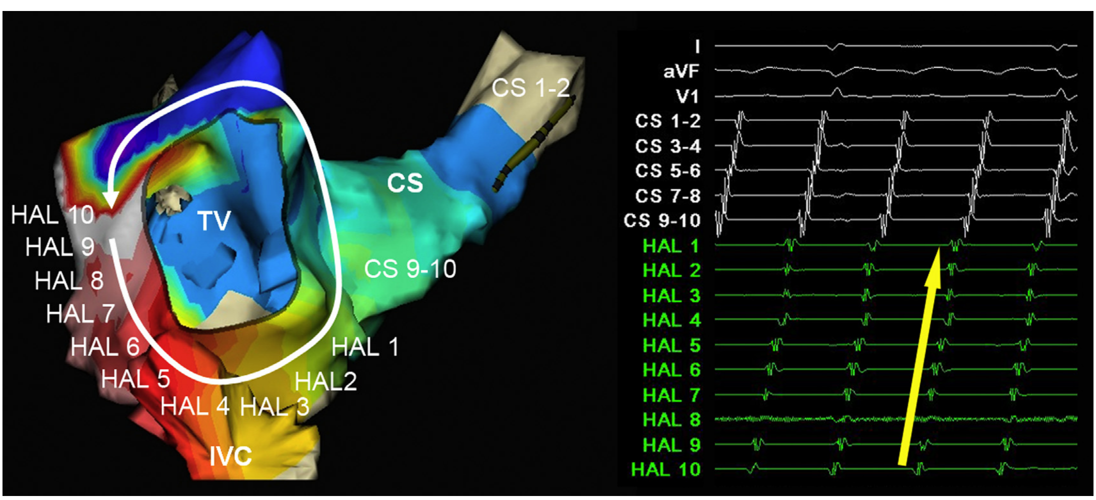

Fig. 2. Activation mapping during typical AFL. Left panel shows that the activation wave front goes downward in the free wall, travels through the cavotricuspid isthmus, spreads upward in the septal wall, and crosses the crista terminalis. Right panel reveals the intracardiac electrogram during typical AFL. Electrodes of halocatheter (HAL) 10 to 4 are located in the free wall, and electrodes of HAL 3 to 1 are located in the CTI. The wave front (*yellow arrow*) activates from HAL 10 to HAL 1 with passive conduction in the coronary sinus (CS). IVC, inferior vena cava; TV, tricuspid valve.