Atrial Flutter Update

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Abstract. Typical atrial flutter has long been considered a reentrant arrhythmia, but it is only recently that the full structure of the right atrial circuit was understood, leading to the devise of ablation techniques. Recognition of the role of functional block, based on anisotropic conduction was crucial to understanding of the flutter circuit. Anisotropy at the terminus creates a line of block that, with the orifices of superior and inferior vena cava, constitutes the posterior boundary of the flutter circuit. The anterior boundary is the tricuspid ring, and the circuit is a ring of myocardium made by the septal and anterior right atrial walls, linked on top by the right atrial roof and inferiorly by the inferior vena cava-tricuspid ring isthmus. This isthmus, a relatively narrow part of the circuit, has become the established target for typical flutter ablation. Complete bidirectional isthmus block is the final goal of flutter ablation. This has to be assessed, after flutter interruption, by pacing both sides of the ablation line while recording electrogram sequences from the opposite right atrial wall and the isthmus itself. Success is great in terms of prevention of flutter recurrence, however a 30% incidence of atrial fibrillation during follow-up casts a large shadow on long-term prognosis.

Understanding of the myocardial abnormalities underlying atrial flutter and fibrillation will be necessary to improve this long-term outlook.

Key Words. atrial flutter, macroreentrant tachycardia, catheter ablation

Introduction

Atrial flutter (AFL) has been defined traditionally as an atrial tachycardia with a rate above 240 bpm and a continuously waving baseline, however, electrophysiologic (EP) studies have put in evidence the inadequacy of current classifications of atrial tachycardias and AFL, based only on the ECG pattern [1]. In the last 10 years better understanding of the reentrant mechanisms of typical and some atypical forms of AFL has lead to catheter ablation, thus changing completely the clinical approach.

Typical Atrial Flutter

The ECG of typical AFL

The most typical ECG of AFL, often called common because of its high prevalence, is a complex waving pattern resembling the edge of a wood saw (saw-tooth pattern) on the inferior ECG leads. This is not a simple negative wave, but a succession of: (1) a slowly descending segment, (2) a rapid negative deflection, and (3) a sharp upstroke that (4) with a slight overshoot, leads to the slowly descending segment of the next cycle (Figure 1). Amplitude of atrial deflections is usually small in leads I, aVL and precordial leads, with the exception of V1, where the ECG shows discrete, P wave-like deflections, that are generally positive or biphasic, but occasionally negative. This ECG pattern is >95% predictive of typical AFL reentry (see below), but it can be mimicked by complex reentry circuits in patients with previous cardiac surgery or catheter ablation for atrial arrhythmias.

Reentrant mechanism of typical AFL

Classical models of reentry are based on the presence of a central obstacle, an inexcitable structure around which activation can turn in one direction. Experimental work by Rosenblueth in the 1940’s [2] demonstrated the feasibility of reentrant activation in the RA of dogs after creating a crushing lesion on the posterior wall, from the inferior (IVC) to the superior vena cava (SVC). In this preparation reentrant activation rotated continuously in a ring of myocardium made by the septal, superior, anterior and inferior RA walls, bounded anteriorly by the tricuspid ring orifice and posteriorly by the artificial barrier created. Activation terminated and could not be reinitiated after the “ring” was cut between the IVC and the inferior edge of the tricuspid ring. This was quite a visionary concept as it reproduces almost exactly the human typical flutter circuit AFL and predicts present methodology for catheter ablation (Figure 2).

It was the concept of anisotropic conduction, developed by Spach [3], in the 1980’s that allowed understanding that RA anatomy is uniquely suited to support reentry. Myocardial fibers packed in parallel along a supero-inferior axis in the terminal crest (TC) are able to conduct very rapidly in the longitudinal direction, but very slowly in the transverse direction with a ratio of 10:1. This remarkable difference in conduction velocity is due to a high resistivity of side-to-side cell coupling [4], related to preferential distribution of gap junctions in end-to-end location [5]. The orifices of SVC and IVC, linked by the TC thus constitute the posterior obstacle and the TR
Fig. 1. The ECG pattern of typical atrial flutter. Spontaneous 2:1 AV conduction obscured the shape of the waves (left), but a higher degree of AV block was produced by carotid sinus massage, allowing full study. For explanation see text.

the anterior obstacle that make the virtual ring of myocardium supporting reentry in typical AFL [6]. In humans the line of block in the posterior RA has been located over the TC by several groups [7,8], but others have found evidence of transverse block over the smooth posterior RA wall [9], perhaps suggesting that, in some situations block may occur at the connections of the TC with surrounding myocardium, rather than within the TC.

As in Rosemblueth’s model, typical AFL activation turns in a ring of muscle bounded anteriorly by the TR and posteriorly by the openings of both venae cavae and the line of functional block in the posterior wall of the RA. Direction of rotation (left anterior oblique view) is counterclockwise in about 90% of the cases in the left anterior oblique view, so that the anterior RA is activated supero-inferiorly and the septal RA infero-superiorly [6]. The superior turning point is generally the RA roof [10,11], between the SVC orifice and the superior rim of the TR, but in some cases activation may go across the superior end of the TC, below the SVC [12].

**Reverse typical flutter**

In the clinical setting 1/10 of typical AFL will show rotation of activation in the clockwise direction (ascending the anterior and descending the septal wall) (Figure 2) [13,14]. This is called reverse typical AFL [1], because it is based on the same anatomic circuit as typical AFL. The more common counterclockwise rotation may be determined by the anisotropic properties of the myocardium at the IVC-TR isthmus making block easier in the clockwise direction at the