

Clinical update

Atrial flutter: more than just one of a kind

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Since its first description about one century ago, our understanding of atrial flutter (AFL) circuits has considerably evolved. One AFL circuit can have variable electrocardiographic (ECG) manifestations depending on the presence of pre-existing atrial lesions, or impaired atrial substrate. Conversely, different (right sided or even left sided) atrial circuits including different mechanisms (macroreentrant, microreentrant, or focal) can present with a very similar surface ECG manifestation. The development of efficient high-resolution electroanatomical mapping systems has improved our knowledge about AFL mechanisms, as well as facilitated their curative treatment with radiofrequency catheter ablation. This article will review ECG features for typical and atypical flutters, and emphasize the limitations for circuit location from the surface ECG.

Keywords

Typical atrial flutter • Atypical atrial flutter • ECG • Cavotricuspid isthmus dependent

Introduction

Since its first description a century ago, our understanding of atrial flutter (AFL) has evolved, from a relatively simple and unique electrocardiographic (ECG) pattern corresponding to a right atrial macroreentry, to a variety of atrial tachycardias (ATs) originating from the right atrium as well as the left atrium, and resulting from different mechanisms. The use of multielectrodes catheters and the recent development of sophisticated computerized electroanatomical mapping with virtual anatomical chambers reconstruction and fusion with the actual anatomical radiological image has improved our knowledge of AFL circuits and foci location. These technological improvements have also facilitated curative treatment with radiofrequency (RF) catheter ablation while simultaneously creating some terminological and conceptual confusion about its nature.

Historical review and clinical perspectives

The term *flutter* first appeared a century ago in 1887, with Mac William who described the visual phenomena resulting from 'faradic stimulation of the auricles which sets them into a rapid flutter'. It was only 23 years later that Jolly and Ritchie, using the Cambridge model of Einthoven's string galvanometer recorded the first ECG example of AFL.²

A single wave circus movement mechanism was initially proposed by Lewis, ³ but the possibility to reproduce the ECG morphology of AFL with high pacing rate or with focal aconitine injection supported a focal mechanism as another possible hypothesis. ^{4,5} Although both mechanisms are easily observed in animal models, the circus movement theory has been finally accepted as being by far the most frequent in man. A macroreentrant mechanism was finally proven by detailed mapping in the operating room, as well as in the electrophysiology laboratory.

Clinical perspectives

While detailed epidemiologic studies of atrial fibrillation (AF) exist, similar studies of AFL are less frequent. Atrial flutter occurs <1/10 as often as AF. Studies from the Marshfield Epidemiologic Study Area database have reported that the overall incidence of AFL is $\sim\!88$ per 100 000 person-years. The incidence of AFL in those younger than 50 years is $\sim\!5/100$ 000, but rises sharply to 587/100 000 in those $>\!80$ years old.

Atrial flutter coexists with or precedes AF. In a longitudinal study, AF developed in 56% of patients with lone AFL. It has also been shown that 25–82% of the patients who benefited from successful RF ablation for isolated typical AFL will experience new onset of AF during the follow-up. The close inter-relationship between AF and AFL is complex. Some authors have shown that patients with coexistent AF and AFL should benefit from RF catheter ablation of AF, eventually associated with AFL ablation instead of AFL ablation

only. 11 It is accepted that patients presenting with AFL must benefit from the same anti-thrombotic prophylaxis as for AF, according to the presence of a significant thromboembolic risk (CHA₂DS₂-VASc score). The periablation period for AFL should include the same cautions as for elective cardioversion for AF.

Classifications of atrial flutters

In 1970 Puech and Grolleau proposed a classification of AFL according to the ECG morphology. ¹² The most frequent form of flutter was named 'common' if predominantly negative biphasic flutter waves were seen in inferior leads with a sawtooth pattern, which preceded the positivity in V1; AFL was termed 'atypical' or 'rare' if the ECG morphology was different from the common type. ¹²

Another popular and more recent classification was based on baseline atrial rate, stable intracardiac electrograms rate and morphology, and the ability to transiently entrain the tachycardia based on published criteria. ¹³

In 2001, an international group of experts proposed the following definition of ATs and AFLs¹⁴: Atrial tachycardias are regular atrial rhythms at a constant rate \geq 100 beats/min originating outside the sinus node region. They can be focal or macroreentrant.

Atrial flutter is the ECG aspect of a regular AT with a rate \geq 240 beats/min lacking an isoelectric baseline between deflections. Importantly, all agreed on the fact that neither rate nor lack of

isoelectric baseline was specific for the tachycardia mechanism. Atrial flutter is termed typical [cavotricuspid isthmus (CTI)-dependent] if the inferior pivot point is the area bounded anteriorly by the inferior part of the tricuspid orifice, and posteriorly by the inferior vena cava orifice and its continuation in the Eustachian ridge (Figure 1A).

Although this classification clearly limited the use of the term flutter to the sole continuous undulating ECG pattern, in daily clinical practice the word flutter is frequently used to describe any type of fast AT independently of the ECG presentation. This confusing use of the term flutter is probably due to the fact that, for practical and ablative reasons, the final arrhythmia diagnosis is based solely on intracardiac electrogram and result of ablation. 15,16

This article will review ECG features of typical flutters and of various ATs with a flutter pattern, which will be termed for this discussion as atypical.

Typical atrial flutters

Counterclockwise typical flutter

Still frequently referred to as common or type I flutter, this is the most frequent type of AFL. It is a remarkable arrhythmia in that it is very similar in morphology between from patient to patient, and has a constant cycle length with almost no variation between cycles. Its mechanism is macroreentry confined in the right atrium, with typically a

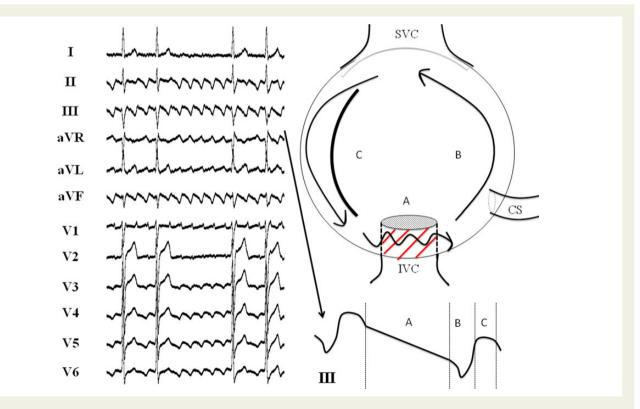


Figure I Typical counterclockwise atrial flutter, and anatomical correspondence of the flutter wave to the electrocardiographic morphology. The flutter waves are best seen during carotid sinus massage (see text for description). (A) Plateau phase (conduction in the cavotricuspid isthmus). (B) Ascending conduction on the septal wall. (C) Descending activation on the lateral wall. CS, coronary sinus; IVC, inferior vena cava; SVC, superior vena cava.

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descending wavefront in the lateral wall and ascendant on the septum with passive activation of the left atrium (Figure 1B and C). The circuit is bounded anteriorly by the tricuspid valve and posteriorly by a combination of anatomic obstacles (orifices of superior vena cava superiorly, inferior vena cava inferiorly and Eustachian ridge posteriorly) and anatomo-functional barriers (region of the crista terminalis or of the sinus venosus). 17-19 As the atrioventricular transmission is almost always 2:1, manoeuvres to increase the degree of atrioventricular block such as carotid massage may be required. The characteristic 'sawtooth' pattern is seen in the inferior leads, which is due to an initial gradual downsloping plateau segment followed by a sharp steep descent, and then by a sharp ascent with a low amplitude terminal positive component, which continues into the subsequent plateau. In the precordial leads, lead V1 shows an initial isoelectric line followed by a positive component which falls always later than the negative component of the inferior leads. This produces an 'overall impression of an upright flutter wave in V1'.²⁰ Lead I is low amplitude/isoelectric and aVL usually upright.

This classic appearance may occasionally show morphologic variations, and has led to a classification into three types of ECG patterns for counterclockwise (CCW) CTI-dependent flutters based on the presence and type of the initial positive deflection. ²¹ A terminal positive component of the F-wave in typical CCW flutter seems to identify a patient population with a relatively high likelihood of heart disease, higher incidence of AF and left atrial enlargement. It should be stressed that severe right atrial disease/conduction disturbances

may yield strange ECG patterns and the typical circuit may then be difficult to diagnose (Figure 2).

Counterclockwise lower loop reentry

At times typical AFL may become irregular and/or faster and this led Cheng in 1999 to describe what we consider as a variant of typical flutter: lower loop reentry.²² The circuit is localized in the lower right atrium, but is also CTI dependent. The circuit involves the lower right atrium, as manifested by (i) an early breakthrough in the lower right atrium, (ii) wavefront collision in the high lateral right atrium or septum and (iii) conduction through the CTI. Alternating lower loop reentry and typical AFL or variable breakthrough sites in the lateral right atrium may result in cycle length oscillation. Of note, the left atrium and the septum are activated in a similar sequence to CCW typical AFL, giving negative atrial complexes in the inferior leads. The morphology of the flutter wave is determined by the site of the breakthrough of the wavefront at the crista terminalis. If the breakthrough occurs at the low lateral right atrium, the resulting clockwise (CW) ascending wavefront will collide with the CCW wavefront propagating from the inter-atrial septum and right atrial roof, thus abolishing the late descending wavefront seen in typical CCW AFL on the lateral RA wall. Then, the late positive deflection seen on the flutter wave in the inferior leads during CCW typical AFL will be attenuated during lower loop reentry circuit, by abolition of these late inferiorly directed forces.²³ The exact aetiology of the different ECG patterns is incompletely known

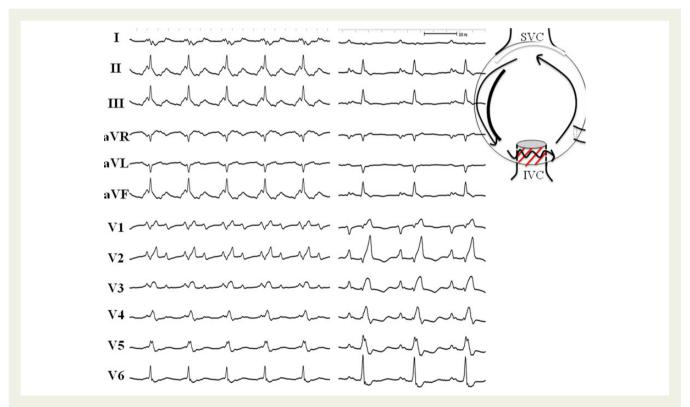


Figure 2 Typical counterclockwise atrial flutter in a 16-year-old female with Ebstein disease. Even despite the limitation of interpretation because of the 2:1 AV transmission, it can be seen that the aspect does not suggest the mechanism of tachycardia. This is due to the altered right atrial impulse propagation as seen during sinus rhythm after successful cavotricuspid ablation. Precordial leads are magnified for this figure. CS, coronary sinus; IVC, inferior vena cava; SVC, superior vena cava.

(between CCW and CW AFL). The presence of an atrial myopathy, and/or scarred atrium may markedly influence ECG morphology.

Double-wave reentry

Another type of acceleration of typical flutter with the same ECG morphology can be induced by pacing in the electrophysiological laboratory. This is caused by two successive activation wavefronts circulating in the same direction along the same reentrant circuit (double-wave reentry). All of the double-wave reentry episodes in the initial report were transient and blocked in the CTI. The clinical significance of this rarely observed phenomenon is unknown.²⁴

Partial cavotricuspid isthmus (sub-Eustachian) short circuit

Counterclockwise AFL may be spontaneously associated with premature activation of the coronary sinus (CS) ostium and impulse collision at the isthmus of both the orthodromic CCW wavefront and another front emerging from the CS ostial region. This has also been observed with a sudden and sustained cycle length prolongation or after previous RF pulse delivery in the anterior portion (sub Eustachian) of the CTI. This may be due to a partial conduction within the Eustachian ridge allowing short circuiting the circuit posterior to the CS ostium, ^{26,27} or to the presence of a pectineate muscle band from the crista effectively separating the isthmus into anterior and posterior compartments. ²⁸

Dual loop reentry during typical flutter

Typical AFL with a CCW loop around the tricuspid valve but sharing a common anterior channel with a CW loop around a lateral atriotomy scar are often seen after post-atrial septal defect surgical closure. ²⁹ Radiofrequency delivery in the CTI transforms the tachycardia without any pause to a different morphology tachycardia with different axis and morphology but nearly the same cycle length owing to rotation around the periatriotomy loop alone. This arrhythmia typically requires ablation of a second isthmus: between one end of the atriotomy and a natural obstacle.

Clockwise typical flutter

In $\sim 10-30\%$ of typical AFLs, the reentrant circuit and the anatomical/functional constraints are identical within the right atrium, but rotates in a CW direction around the tricuspid valve in a left anterior oblique perspective. A high percentage of these AFLs may be induced in the electrophysiology laboratory or occur after ablation of CCW typical flutter. In our initial series, the classic 'sawtooth' pattern was observed in 14 of 18 CW flutters. Although frequently referred to as 'positive flutter wave in the inferior leads', we found that a shorter plateau phase, a widening of the negative component of the F-wave (both possibly suggesting an inconstant impression of positivity) and a negative and frequently bifid F-wave in V_1 were its most consistent findings. A positive F-wave in V6 follows after the negative one in V1 (Figure 3).

Clockwise lower loop reentry

In one study of 12 patients with positive flutter waves in the inferior leads suggesting CW typical AFL, it was found with entrainment pacing that the reentrant circuit involved was the lower right

atrium around the inferior vena cava in 7 patients, a figure-of-8 double-loop reentry around both the inferior vena cava and tricuspid annulus in 4, and a single reentrant loop around the tricuspid annulus in $1.^{32}$

Catheter ablation of typical atrial flutter

After the initial attempts at direct current fulguration, ³³ typical flutters are amenable to RF catheter ablation with high success rate independently of the direction of the rotation or circuit shortcuts, with the same endpoints. 34-36 Careful confirmation of CTI dependency of the circuit is always the first step of the procedure, using entrainment-guided-mapping techniques. This is especially critical when ECG presentation is not typical as may be the case in postoperative or post-atrial ablation patients, in the presence of severe intra-atrial conduction disturbances, antiarrhythmic drugs or congenital heart disease. In these cases, confirmation of CTI-dependency is mandatory, although it may sometimes be difficult or even misleading.³⁷ A continuous line of ablation across the CTI has become the standard therapeutic approach. The endpoints of RF catheter ablation are now standardized: besides flutter termination and creation of a complete line of block (double potentials), the persistent CTI bidirectional block should be assessed by pacing techniques. More recently, some authors have proposed an ablation technique targeting preferentially high-voltage electrograms within the CTI, corresponding anatomically to muscle bundles.³⁸

This therapeutic approach is now proposed as a first-line therapy with high success rate, rare complications and uncommon late recurrences in experienced hands. $^{39-42}$

Intra-isthmus reentry

This is a recently described entity which may be included in the group of typical AFLs. 43 The surface ECGs show typical CCW pattern in most patients. Analysis of the tricuspid annulus electrograms may show spontaneous shifts from a CCW to CW or fusion patterns during ongoing flutter. Fractionated potentials spanning over 34-71% of the tachycardia cycle length are always recorded within the CTI, whereas double potentials are also often seen. Successful ablation always occurs at the area with highly fractionated potentials. Intra-isthmus reentries were mostly found in patients with a redo procedure after previous CTI ablation. Although still debated, the circuit seems confined within the CTI itself, and bounded by the medial CTI and the CS ostium. If the term typical is to be applied to reentrant circuits that are strictly dependent on the CTI, then this is not really the case in the Yang's series of intra-isthmus reentry, as part of the CTI is frequently out of the circuit and such a flutter can even occur in case of proven complete bidirectional CTI block.⁴⁴ Careful entrainment mapping just outside the CS ostium can facilitate the diagnosis of this unusual variant (Supplementary material online, Figure S1).45

Atypical atrial flutters: right atrium

Upper loop reentry

A non-CTI-dependent reentrant circuit involving the upper portion of the RA has been termed upper loop reentry tachycardia. Its circuit has been incompletely characterized. The rotation can be CW or CCW but always crosses the upper portion of the crista terminalis

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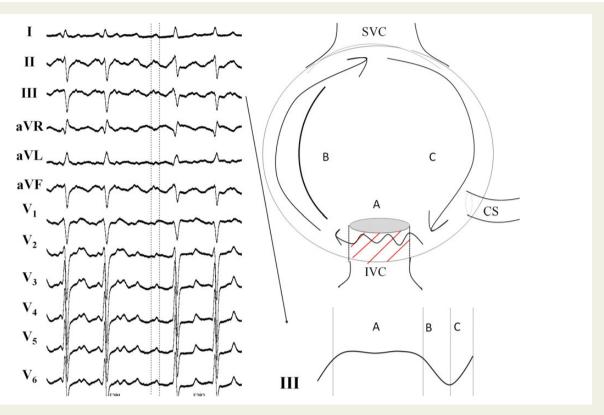


Figure 3 Typical clockwise atrial flutter. It is difficult to describe the F waves as positive or negative in the frontal plane, but the negative bifidity in V1 is highly suggestive of typical clockwise right atrial rotation. (A) Plateau phase (conduction in the cavotricuspid isthmus) included within the vertical lines. (B) Ascending conduction on the lateral wall. (C) Descending activation on the septal wall. CS, coronary sinus; IVC, inferior vena cava; SVC, superior vena cava.

where ablation is successful in eliminating the circuit. This circuit is non-CTI dependent, and will typically have a shorter cycle length, but frequently presents with flutter wave morphologies similar to CW typical AFL in the inferior leads. In one study the presence of negative, isoelectric/flat flutter or extremely low positive amplitude (<0.07 mV) wave in lead I was suggestive of upper loop reentry (regardless of the rotation), whereas CW flutter F-wave was constantly positive in lead I. 47

Non-scar-related right free wall atrial flutter

In 2000, a small series of non-CTI-dependent AFLs were identified in six patients presenting with a typical AFL ECG pattern. ⁴⁸ Most had structural heart disease with biatrial dilation, some had been operated but none had previous right atriotomy (except one for whom the atriotomy scar was not involved in the circuit). The surface ECG was judged identical to that of typical flutter in all but for two patients in whom polarity was positive in the inferior leads during ongoing flutter. A large lateral right atrial circuit was observed for which the participation of the crista terminalis was excluded. Ablation was successful after creation of a line between the inferior part of the circuit and the inferior vena cava.

Scar-related right atrial flutter

In a large number of cases, right atrial macroreentrant ATs present with a flutter-like ECG appearance. The central obstacle(s) of the

circuit may be an atriotomy scar, a septal prosthetic patch, a suture line, or a line of fixed block secondary to prior RF catheter ablation. Other obstacles may include anatomic structures located in the vicinity of the scar (superior vena cava, inferior vena cava).

The ECG aspect of scar-related right AFL is highly variable; it depends on anatomic location, direction of the rotation, the presence antiarrhythmic drugs or of coexisting conduction disturbances in the atrium, the existence of a simultaneous peritricuspid circuit and the presence of pre-existing CTI block. Depending on the predominant direction of septal activation, right atrial free wall flutter can mimic either CW or CCW flutter morphology. A negative F-wave in lead V1 will almost certainly identify the right atrial origin of the arrhythmia.

The best characterized atriotomy macroreentrant AT is due to activation around a surgical incision scar in the lateral right atrial wall, with the incision having a supero-inferior axis. Low-voltage electrograms characteristic of areas of scar can be observed during both sinus rhythm and AFL. A line of double potentials is recorded in the lateral right atrium, extending vertically (supero-inferior), corresponding to the atriotomy scar. They are large in the middle of the incision scar and tend to be narrow as the catheter approaches the scar end only to fuse at its superior and inferior ends. Linear RF lesion extending from the inferior portion of the scar (where double potentials fuse) to the inferior vena cava will disrupt the circuit and eliminate the tachycardia. Typical AFL can be associated with right atriotomy tachycardia sequentially or simultaneously

(dual loop reentry). Ablation of one circuit will unmask the other. Ablation of both circuits is necessary for clinical control of recurrent atrial arrhythmias.

Atypical atrial flutters: native left atrium

Atrial flutter in native left atrium is less frequent than in the right atrium. They are commonly associated with significant left heart disease including mitral valve disease, hypertension, diastolic dysfunction, or heart failure, but in few cases they may be observed even in the absence of detectable left ventricular heart disease. Sinus rhythm mapping studies have revealed zones of slowed conduction and electrically silent areas, which serve as the appropriate substrate for macroreentry.⁴⁹

The ECG of left AFL is particularly difficult to characterize, as it may be similar for various circuit locations. The flutter wave usually shows a prominent positive deflection in lead V1 and uncommonly is flat or isoelectric but we have seen that this aspect cannot be specific as it is also encountered in CCW typical flutter. In a minority of patients, the morphology even resembles typical flutter. Yet a broad upright flutter wave in V1 with upright waves in inferior leads or with low amplitude or isoelectric waves in the other leads is suggestive of a left atrial origin (Figure 4).

Left atrial anterior wall macroreentry

In a small series of six patients without previous surgery or ablation, a figure-of-eight circuit with loops around the mitral annulus (MA) and

a low-voltage (scar) area within the left atrial anterior wall was responsible for a tachycardia with a flutter aspect in the inferior leads in five cases. The F-wave was broad-based upright or \pm V1. This form may be considered as a sub-type of perimitral flutter (see below).

Coronary sinus atrial flutter

Olgin *et al.* reported the case of a patient without structural heart disease with a surface ECG of typical flutter, but in whom the circuit included the ostium of the CS, as demonstrated with entrainment mapping. Activation-mapping revealed double potentials inside the CS. The circuit involved the CS myocardium, exiting in the lateral left atrium, went downwards the inter-atrial septum, and reentered into the CS. The arrhythmia was cured by delivering RF energy within the CS.

Atypical atrial flutters: post-intervention left atrium

The existence of a pre-existing structural heart disease, the development of cardiac surgery at times involving specifically the atrial myocardium and finally the widespread use of RF catheter ablation for AF has led to the emergence of a very large number of regular ATs frequently presenting as AFLs. The most common examples are encountered after pulmonary vein isolation, but especially after extensive atrial ablation including linear lesions and/or defragmentation. Those circuits can have an AFL ECG manifestation, sometimes mimicking a CTI-dependent flutter; they can involve different propagation

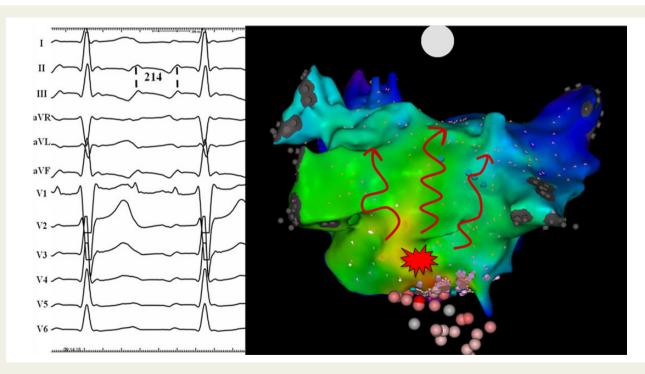


Figure 4 Atrial flutter in a 27-year-old male patient with previous ablation of a postero-septal accessory pathway. The surface electrocardiographic pattern in the inferior leads suggests a typical counterclockwise flutter, but three-dimensional electrocanatomical activation map (here in postero-anterior projection) revealed a microreentry (red star) from the left inferior atrium with ascending propagation in the posterior wall (red arrows).

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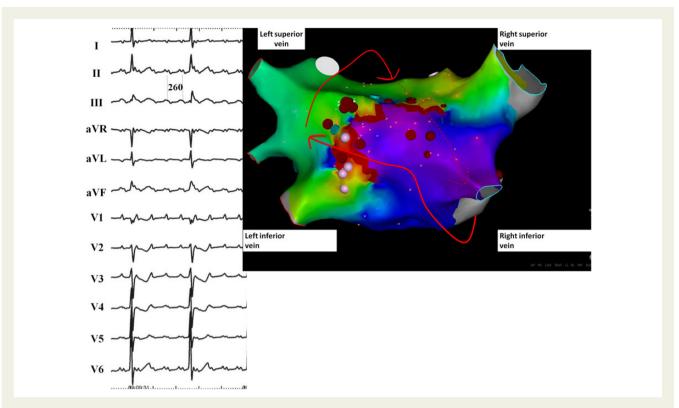


Figure 5 Atrial flutter electrocardiographic (and three-dimensional electroanatomical map in postero-superior projection) in a 73-year-old patient with four previous left atrial catheter ablation procedures. Tachycardia was a left atrial macroreentry (red arrows) caused by a gap in a previous roof line.

types (macroreentrant, microreentrant, or focal) (Supplementary material online, *Figure S2*).

Many of these tachycardias occurring after circumferential pulmonary vein isolation are reentrant, and related to gaps in prior ablation lines. Perimitral, roof-dependent (Figure 5), and septal circuits are the most frequent mechanism of left atrial macroreentrant ATs. 52,53 Recently, even biatrial circuits have been reported.⁵⁴ Prior atrial lesions make any attempt of location of the site/chamber of origin based on flutter wave morphology very hazardous. Indeed, the significant modification of intra- and inter-atrial propagation after circumferential pulmonary vein isolation (and even more after more extensive lesions) is almost always accompanied by a flutter wave distortion that is also encountered during sinus rhythm. In other cases, the flutter wave is modified during tachycardia because of intra-atrial delay due to RF-induced lesions, but the p wave during sinus rhythm is not necessarily modified (Supplementary material online, Figure S3). Despite these limitations two types have been relatively characterized on the ECG.

Left septal atrial flutter

A single report of an 11-patient series revealed that the F-wave in V1 was predominantly positive in case of CCW rotation, and negative in case of CW rotation, whereas the limb leads most of the time reveal very low voltage or flat F-wave morphology. The flutter circuit was found to rotate around the left septum primum with a critical isthmus located between the pulmonary veins (PVs) posteriorly and/or mitral valve anteriorly and the septum primum. 55

Perimitral atrial flutter

The perimitral flutter is a macroreentrant circuit rotating around the mitral annulus and low-voltage areas or left atrial scars in the atrial wall. In a study of 39 tachycardias in 31 patients, Gerstenfeld et al. described the ECG characteristics of perimitral flutters. 56 The polarity in each lead was determined by examining the F-wave during the 80 ms before the tallest peak positive deflection in V1. Counterclockwise perimitral flutter was positive in the inferior and precordial leads and had a significant negative component in leads I and aVL. Clockwise perimitral flutter demonstrated the converse limb lead morphology with a significant negative F-wave in the inferior leads and positive F-wave in leads I and aVL. A proximal to distal CS activation was best at differentiating CCW perimitral flutter from left pulmonary veins ATs, while a distal to proximal CS activation was best at differentiating CW perimitral flutter from CCW typical right AFL. The electrophysiologic diagnosis of perimitral flutter is relatively easy with entrainment pacing techniques using a single CS multipolar catheter when the post-pacing interval is < 30 ms in the proximal as well as the distal CS, and more recently with the demonstration of intracardiac fusion when pacing downstream and recording late antegrade activation from the upstream poles of the same catheter. ⁵⁷ This arrhythmia is particularly difficult to treat as bidirectional mitral isthmus block completion has limited impact on arrhythmia recurrence because it may be challenging to acutely achieve, requiring potentially dangerous epicardial ablation within the CS in up to 60% of cases with significant late conduction recovery despite acute block completion^{58–61} More recently, the modified mitral anterior line has been

shown to be safer and efficient compared with the lateral line, improving the percentage of mitral isthmus block.⁶²

Pulmonary veins-related atrial tachycardia

Atrial tachycardias after RF AF ablation can be due to reentry of variable size using gaps in the line surrounding the pulmonary veins, ⁵³ larger macroreentry turning around the superior and the ipsilateral inferior PV or to focal PV discharges. Pulmonary vein-related ATs can sometimes manifest with a flutter ECG aspect in case of associated slow intra-atrial propagation resulting from the previous atrial ablation, as illustrated in Supplementary material online, *Figure S3*. Some algorithms are useful to differentiate ATs originating from perimitral reentry. A negative component in lead I, when present, can differentiate CCW perimitral flutter from left pulmonary veins ATs. ⁵⁶

Conclusion

Atrial flutter classically refers to the ECG pattern of an undulating wave with no electrical silence in at least one lead of the surface ECG. At the time of frequent catheter ablation, where deep understanding of the arrhythmia mechanism is mandatory, this terminology may be considered as having less interest in that it has limited value for precise anatomic localization of reentrant circuits or site of tachycardia origin. Yet the most representative counterexample is typical CCW AFL for which the ECG predicts a right atrial macroreentrant CTI-dependent flutter with the highest accuracy especially in the absence of structural heart disease or previous ablation. If the other flutter pattern may also suggest a reentrant circuit, this is indeed not specific as it may result from variable mechanisms (macroreentrant, microreentrant, or focal source) in variable localizations (left atrium or right atrium). It is thus fair to say that after its long history, atrial flutter is now, by far, more than just one of a kind.

Supplementary material

Supplementary material is available at European Heart Journal online.

Conflicts of interest: none declared.

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