FLUTTER WAVE POLARITY ON SURFACE ECG AND ENDOCARDIAL ACTIVATION IN TYPICAL COUNTER CLOCKWISE ATRIAL FLUTTER

Zahid Aslam Awan, M Gallagher, E Rowland, AJ Camm

Department of Cardiology
St. Georges Hospital Medical School, London, UK.

ABSTRACT

Objective: To analyse the endocardial activation of typical counter clockwise atrial flutter (CCW).

Material and Methods: A retrospective study of 24 cases admitted over a period of 5 years for atrial flutter ablation at St. Georges Hospital, London. The electrophysiological study were reviewed from optical disc and right atrial activation analysed in all cases of typical CCW atrial flutter.

Results: In all the 24 cases of typical CCW atrial flutter the right atrial activation is in upward direction along the septum and downward along the right atrial lateral wall, the inferior leads on ECG represent it as “F” waves.

Conclusion: In CCW atrial flutter the negative flutter wave in inferior leads represent lateral and anterior right atrial activation while descending limb represents septal activation.

Key words: Typical Counter Clock, Atrial Flutter.

INTRODUCTION

Counter clockwise (CCW) atrial flutter is the most common macro reentrant atrial tachycardia confined to the right atrium. It was first described by Jolly and Ritchie in 1911 as a saw toothed configuration of atrial waves in leads II and III. Lewis in 1925 described its mechanism as circus movement endocardial activation around the superior and inferior venacava.

The classification of atrial flutter has mostly been based on morphology of flutter wave on surface ECG. Puech in 1970 classified atrial flutter as:

1. The common or typical form characterized by predominantly negative flutter
‘F’ wave in inferior leads II, III, AVF and V6 with a rate ranging from 250-330 bpm.

2. Atypical form characterized by positive ‘F’ waves in V6 and having same rate as common atrial flutter.

3. An impure flutter with rate > 320 bpm identified as transitional pattern between pure atrial flutter and fibrillation.

Because of a constant and specific endocardial activation of counter clockwise atrial flutter, its presentation on surface ECG has always been of interest. Propagation of impulse through isthmus is represented by Plateau phase of flutter, which is especially prominent in inferior leads\textsuperscript{4,5,6}. Schmitt et al in their prospective review of 40 patients observed a close correlation of the flutter wave polarity on surface ECG to the endocardial wave front rotation in right atrium\textsuperscript{7}. However according to LP Lai et al the correlation of flutter wave polarity in inferior lead and direction of endocardial activation is not very consistent\textsuperscript{8}.

We are presenting our retrospective review of 24 cases of Counter clockwise atrial flutter to analyze the relationship of different components of Flutter wave on surface ECG and endocardial activation in right atrium as expressed by a duodecapolar Halocatheter deployed at Tricuspid annulus in right atrium.

**MATERIAL AND METHODS**

The electro physiologic studies were reviewed from the optical discs in Bard EP system. All these patients were referred for radiofrequency ablation of atrial flutter during the year 1996 – 2001 to St. Georges Hospital and Medical School, London.

Counter clock wise (CCW) atrial flutter was defined as an atrial flutter with craniocaudal activation of the anterior and lateral walls of the right atrium and caudocranial activation of the atrial septum as shown by the Halo catheter recordings. Clockwise (CW) atrial flutter was defined as

![Diagram](image)

Fig 1: Arrows showing endocardial activation in CCW atrial Flutter.
an atrial flutter with a similar flutter cycle length and reverse activation sequence of the counter clockwise flutter. Atypical atrial flutter was defined as an atrial flutter other than the CCW and CW atrial flutters.

The diagnosis of typical CCW atrial flutter was confirmed by intraatrial recordings from Halo catheter and the isthmus dependence by concealed entrainment and catheter ablation. The duodecapolar Halo catheter (Cordis Webster) was positioned close to tricuspid annulus for recording the activation of the lateral and anterior right atrial wall and the interatrial septum. The distal pole of Halo marked 7 o'clock and proximal pole marked 2 o'clock positions on tricuspid annulus in LAO° projection on fluroscopy. The proximal pole of a quadripole CS catheter marked the CS OS and its distal pole represent left atrial activation.

The polarity of the lead II, III, aVF, V6, aVL, I and V1 on surface ECG was analyzed on the same screen in reference to the endocardial activation as represented by
Halo catheter. All the recordings were interpreted by two blinded observers. The temporal relation ship between endocardial activation and surface ECG was determined by means of electronic callipers. Flutter waves with 3:1 or higher atrioventricular conduction relation were considered for analysis to avoid misinterpretation from interference with QRS complexes or T waves.

RESULTS

The surface ECG of all the 24 CCW atrial flutter showed flutter waves of typical saw tooth configuration with negative Polarity in inferior leads and positive in lead V1 (Fig. 3). CCW atrial flutter showed positive or biphasic in lead II, III, aVF with a varying morphology in lead V1.

In all the cases of CCW atrial flutter, the ascending part of the negative flutter wave in inferior leads, V6 and positive deflection of V1, were found to be synchronous with the activation of the lateral wall of right atrium as represented by the Halo signals from Halo P to H 8.

Septal and left atrial activation is represented by the descending limb of the negative flutter wave in anterior leads and positive component in lead aVL and V1. Proximal CS activation begins almost simultaneously with activation of the low septal area, distal CS pole represents left atrial activation.

Propagation of impulse through isthmus is represented by Plateau phase of flutter, which is especially prominent in inferior leads. All these findings are consistent with that reported by Nadir Saoudi and G Nadrepepa.

In our review ECG lead I mostly looked flat or equiphaseic and has not shown characteristic polarity unlike that reported by G. Nadrepepa and Lp Lai et al. Only three patients presented with clockwise atrial flutter.

DISCUSSION

In the era of ablation, surface ECG analysis is of prime importance in clinical decision making.

A flutter that looks common in the limb leads may in fact be due to various mechanisms. In this study it has been shown that atrial flutters with apparently similar ECG aspects have diametrically opposite impulse propagation.

Josephsons and Cosio et al demonstrated common atrial flutter to be a reentrant rhythm, the wave travelling up the septum and down the free wall of the right atrium\textsuperscript{11,12}. The circuit being confined to right atrium bounded interiorly by Tricuspid annulus and posteriorly by Crista, IVC and Eustachian ridge. The term counter clockwise is used when it moves up the septum and down the lateral wall and clockwise when it moves in reverse direction. (Fig 1, 2) Electroanatomic mapping has also confirmed the CCW A. Flutter circuit to be confined to right atrium and left atrial activation as bystander through CS, Buchmanns bundle and or Fossa ovaris.

The bulk of anatomical and clinical data from Cosoi FG and Saoudi N provide support of the macroreentrant atrial circuit being in 80% to 85% of the cases located in the right atrium in atrial flutters.\textsuperscript{13,14} In our study also the exact inversion of the wave front propagation along the Halo catheter, the His bundle, and the ablation catheter with inversion of septal activation but with identical left atrial depolarisation in both types of rotations again strongly strongly suggests a purely right atrial circuit. As emphasized by Waldo and Saoudi our study also confirms that the polarity of the F wave morphology in the Inferior leads may be predominantly determined by left atrial
propagation. Although Puechs classification relates intracavity recordings to surface ECG, it does not include a purely right atrial clockwise circuits. Further studies are critically needed to better individualize the various forms of flutter circuits, paving the way of new classification in which the surface ECG would provide more clinically useful information.

The major limitation of this study is the limited representation of the right atrial endocardial activation by Halo catheter at tricuspid annulus. The sample size of 24 cases is small to make a generalisation. Our number of patients with CCW atrial flutter is small despite the fact that more than 100 patients during the year 1996 to 2001 had isthmus ablation for isthmus dependent atrial flutter at our institute. This is because it has been our policy not to try hard to induce atrial flutter during the EP study if the patient already has documented evidence of typical atrial flutter to avoid the risks of inducing atrial fibrillation.

Different gains and papers speed has been used to analyse the surface ECG for different patients to get the best wave morphology, this can account for biased approach.

To conclude in CCW atrial flutter there is a fixed representation of the endocardial activation of the flutter wave front on the surface ECG. The ascending limb of the negative flutter wave in the inferior leads represent lateral and anterior right atrial activation while the descending limb of inferior leads is representative of septal activation. The conduction across isthmus is marked by plateau between the negative ‘F’ waves on surface ECG especially prominent in inferior leads.

REFERENCES

13 Cosio FG, Arribas F, Lopez Gil M, et al. Endocardial catheter mapping of


Address for Correspondence:
Dr. Zahid Aslam Awan,
Cardiology Department,
Hayatabad Medical Complex,
Peshawar.
Email: ccfzahid@netscape.net