Hypokinetic Arrhythmias Arising After Several Months from ATC for Complex Atrial Arrhythmia (Atrial Fibrillation and Atrial Flutter)

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Abstract

In this article are reported hypokinetic arrhythmias (asystole or AVB 3°) arising after several months from ablation procedure that needed definitive pacemaker implantation. This event, coming in patients submitted to ablation of left atrial roof and cavo-tricuspid isthmus area, could be considered, primarily, complications of ablation. However, their appearance long time after the RF-TCA let us to consider them autonomic and independent events.

The observation of these events opens a patho-physiological discussion in relation to current knowledge and we suggest these three hypothesis: a)”Electric remodelling as a result of ablation procedure”; b)”Development of the natural history of AF”; c)”Random observation”.

ABBREVIATIONS


INTRODUCTION

Radiofrequency transcatheter ablation (RF-TCA) is one of the new strategies used for the treatment of atrial fibrillation (AF), its success rate ranges from 32% to 90% according to the kind of AF, the site that received radiofrequency and the therapeutic protocol used [1-4]. Early (< 7 days after the procedure) and late (> 7 <60 days from the day of the ablation) complications after RF-TCA are known; their incidence ranges from 0,8% to 5,2% according to the ablation technique used [5]. In this article, we describe hypokinetic arrhythmias coming 11, 16 ± 4, 6 months after ablation procedure, that needed definitive pacemaker (PM) implantation. This event, coming after a RF-TCA could be considered complications of ablation. However, their appearance long time after the RF-TCA let us to consider them autonomic and independent events. The incidence and coincidence event stimulated a patho-physiological discussion in relation to current knowledge. Except the events arising after AF ablation, two other cases of arrhythmia, arising after flutter ablation, are reported to complete this topic.

Below we report the clinical history of the 6 patients (pt) under discussion.

CASE PRESENTATION

CASE N° 1

A 59 year old man, affected by persistent AF (pAF), with transient ischemic attack (TIA), vascular cerebral disease, patent foramen ovale (PFO), multinodular thyroid disease, was admitted (09/2010) because of pAF (EHRA III). An electrophysiology study (EPS) was performed and showed “AV node Wenckebach 450 ms, AV node refractory time 400-350-1 90 ms, after isoproterenol
and right atrial burst 180 ms, ectopic beats came from right pulmonary veins and became AF with an high ventricular response. Radiofrequency energy was erogated by a 4 mm catheter ablation (Safire), M curve, obtaining encircling of pulmonary veins. Biphasic synchronized shock of 130 J had success to convert to sinus rhythm, 70 bpm.

He was discharged with the indication to follow the therapeutic protocol with flecainide, sotalol, atorvastatin, omega fatty acids, acenocumarol. He was in sinus rhythm at 1,3,6 months of follow up. During the 8th month of follow up, after TCA, he had syncope. Holter electrocardiogram (ECG) showed an advanced AV block, with a RR distance of 11 seconds. He had a definitive PM implantation (St. Jude Medical PM). He resulted asymptatic and in sinus rhythm at 12, 15, 18 and 24 months follow up.

**CASE N° 2**

A 62 year old man, affected by persistent AF (pAF) (first episode in 2005), with hypertension, thyroid disease treated with levothyroxine, was admitted (10/2011) because of pAF (EHRA II). An electrophysiology study was performed and showed “Sinus node recovery time (600 ms): 1387 ms, corrected 193 ms; (700 ms) 1747 ms, corrected 408 ms; (800 ms) 1664 ms, corrected 364 ms. 220 ms atrial burst, with isoproterenol iv induced a cavotricuspid isthmus (CTI) dependent atrial flutter (cycle 247 ms, HR 110 bpm), confirmed by an entrainment which became a left atrial flutter and then AF.” Radiofrequency energy was erogated in the target point of CTI. He was discharged with the indication to follow the therapeutic protocol with flecainide and sotalol for 3 months. He had a good life until February 2013 (16 months after the ablation), then he had different episodes of dizziness and lightheadness. He had an EPS which showed “Sinus node recovery time (600 ms): 1965 ms, corrected 651 ms; (700 ms) 1780 ms, corrected 380 ms; (800 ms) 1590 ms, corrected 340 ms. AV node Wenckebach 450 ms”. An atrial- sinus disease was diagnosed. He had a definitive PM implantation (St. Jude Medical PM). He is asymptomatic and in sinus rhythm now.

**CASE N° 3**

A 62 year old woman has affected by persistent AF (pAF) for 5 year, with hypertension. In the past (05/2006) she had a slow- fast node ablation. On 2010, she was admitted because of pAF (EHRA III). She had an EPS and then she was ablated, obtaining encircling of pulmonary veins and ablation of left superior ganglia plexi. She was discharged in sinus rhythm and then it converted in Sinus rhythm, stopped by a sinus arrest of 7,3 s. She had a definitive PM implantation 5 months after the ablation. She is asymptomatic and in sinus rhythm now.

**CASE N° 4**

A 62 years old woman affected by p AF, hypertension, diabetes mellitus type 2, TIA, PFO with a no significant shunt, thromboendarterectomy right carotid artery in 2008. In the past (2009) she was admitted to our cardiology department due to syncopes, sometimes reporting trauma. In July 2010 she was admitted because of pAF (EHRA III) and a EPS was performed. She received RF-TCA and encircling of pulmonary veins, atrial roof and right superior ganglia plexi were ablated. She was discharged in AF with an indication to follow the therapeutic protocol with: flecainide, sotalol, atorvastatin, omega fatty acids, acenocumarol.

She was in sinus rhythm at 1,3 months of follow up with EHRA I class. During the 5th month of follow up after TCA, he had syncope. She was studied and PSVT was documented. It became an AF and then it converted in Sinus rhythm, stopped by a sinus arrest of 7,3 s. She had a definitive PM implantation 5 months after the ablation. She is asymptomatic and in sinus rhythm now.

**CASE N° 5**

A 78 year old woman, affected by hypertension, dyslipidemia, thyroid disease. She had a cardiac surgery in 2008 to implant a bio-prothesis in aortic position and to have a mitral plastic with a valvular ring. She was admitted in a hospital because of atrial flutter with high ventricular response in December 2012. An EPS was performed and radiofrequency energy was erogated in the left target side of CTI and arrhythmias was stopped. After 7 months from the ablation, she was admitted in our cardiology department because of lypothymy. She had a wash out time from the therapy. Then a sinptomatic junctional escape rhythm, with HR < 30 bpm was diagnosed. She had a definitive PM implantation. She is asymptomatic and in sinus rhythm now.

**CASE N° 6**

A 79 year old man, with an aortic prosthesis was admitted in 12/2012 because of symptomatic atrial flutter. An EPS was performed and showed "Normal sinus node recovery time, AV node Wenckebach 500 ms, AV node refractory 550/400 ms" Radiofrequency energy was erogated in the target side of CTI and arrhythmias was stopped. He was discharged with the following therapy: amiodarone and atorvastatin. During the follow up at 1 and 3 months he was asymptomatic and in sinus rhythm.After 6 months from the ablation he was admitted because of lypothymy. His ECG Holter showed a first grade AV block (PQ duration 400-420 ms), different daily pauses (> 2,5 < 3,1s), sometimes junctional escape rhythm. He had an EPS which showed “a third grade AV block induced by HR 80”. He had a definitive PM implantation. He is asymptomatic and in sinus rhythm now.

**MATERIALS AND METHODS**

**EPS before ablation**

An EPS was performed in every pt (guidelines indication): Seldinger technique was used to introduce catheters (8F e 6F) from right femoral artery; 7F from right internal jugular vein and 6F from left femoral vein. The catheters were placed as following: CSL 10p in the coronary sinus; CRD on the His bundle, JSN in the right atrium. After heparin was administered, maintaining an ACT>300s, SL1 was introduced in left atrium using a ETE guided transseptal approach with BRK needle.
In case tachyarrhythmias were not spontaneous, isoproterenol (1 to 5 ug/min) was administered iv to induce them. Programmed right atrial stimulations were used to trigger AF. Left atrium was mapped to recognize the most early activation point triggering the tachyarrhythmias.

**Mapping system**

Non fluoroscopic EnSite NavX St. Jude Medical mapping system was used to have 3D left atrium geometry.

**RF-ATC**

Triggers were ablated using radiofrequency energy and irrigated ablation catheter (Safire St. Jude Medical, Minnesota, MN NSA) 4 mm tip, M curve, (average power 33 W ± 9 DS, target temperature 55°C). RF created a tissue injury with coagulative necrosis (Table 1).

**ATC technique:** pulmonary veins (PV) antral isolation, left atrial roof linear lesions and lesion to isthmus between mitral anulus and left inferior PV were performed. Sometimes, after vagal refexxes were stimulated, RF was erogated in ganglia (left superior and right superior). Post ablation testing with coronary sinus stimulation 500 ms confirmed the absence of the arrhythmias and circular catheter Optima 25-15 confirmed the isolation of the pulmonary veins.

**Follow-up after ATC:** All the pts had a clinical and strumental 1, 3, 6, 12, 18 and 24 month follow up. The first consisted of: analysis of symptoms (EHRA score), lifestyle, examination and therapeutic protocol modifications according to pt clinic characteristics. The second one consisted of: ECG, Monitoring Holter ECG and trans-thoracic echocardiogram.

**After ATC therapy:** Therapeutic protocol with flecainide (50 mg x 2), sotalol (20 mg x 3), atorvastatin (80 mg), omega fatty acids (1000 mg x 3) and acenocumarol was followed for 3 months.

The implant procedure for PaceMaker: the procedure was performed under local anesthesia and creating a pocket in the upper chest, under left clavicle region. A bipolar catheter was introduced in the apical septal right ventricle through the left cephalic vein; a bipolar catheter was introduced in the right atrial auricle through the left axillary vein. The bicameral PM was inserted in the pocket beneath the skin.

**After PM controls:** all the pts were visited to control the incision healing and the PM on the seventh day, and to repeat PM control and ehoecardiogram. at 1-3-6 months.

**DISCUSSION**

ATC-RF is a therapeutic approach reporting high success rate, but early and late complications are described. Focusing our attention on early (< 7 days after ATC) arrhythmic complications, Bezold Jarish reflex could be the pathogenetic mechanism of the ipokinetic arrhythmias. It consists of a vagal stimulation and an adrenergic inhibition, after cardiac mechanoreceptors activation, with symptoms related to low heart rate, low blood pressure due to vasodilatation [6-8].

Reversible atrial ventricular block after RF erogation, with a slowing down of the heart rate until to temporary asystole, is caused by a neurocardiogenic reflex. The effects of the autonomic disfunction during RF ablation used to treat supraventricular arrhythmias has been described by different authors [9]. An other early complication during EPS is linked to

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**Table 1:** Characteristics of the patients, ablation technique used and electric anomaly onset after ATC-RF.

<table>
<thead>
<tr>
<th>Pt</th>
<th>Sex</th>
<th>Age</th>
<th>Comorbidities</th>
<th>Arrhythmia</th>
<th>Target ATC</th>
<th>RF (W)</th>
<th>Early Comp.</th>
<th>Late Comp.</th>
<th>Symptoms</th>
<th>Time post ATC</th>
<th>Electric anomaly</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>M</td>
<td>59</td>
<td>TIA</td>
<td>PAF</td>
<td>VP Circ. Abl</td>
<td>25W</td>
<td>/</td>
<td>/</td>
<td>Syncope with trauma</td>
<td>8</td>
<td>Pause 12 sec. + AVB III</td>
</tr>
<tr>
<td>MA</td>
<td>M</td>
<td>82</td>
<td>Hypertension</td>
<td>AF-Flutter</td>
<td>CTI</td>
<td>45W</td>
<td>/</td>
<td>/</td>
<td>asthenia + dizziness</td>
<td>16</td>
<td>SAB II FC&lt;30 bpm</td>
</tr>
<tr>
<td>ST</td>
<td>F</td>
<td>62</td>
<td>Hypertension</td>
<td>PAF</td>
<td>VP. Circ. Abl with left sup ganglia</td>
<td>25W</td>
<td>/</td>
<td>/</td>
<td>asthenia + dizziness</td>
<td>15</td>
<td>Pause 5 sec.</td>
</tr>
<tr>
<td>VE</td>
<td>F</td>
<td>76</td>
<td>Hypertension</td>
<td>PAF</td>
<td>VP. Circ. Abl with right sup ganglia</td>
<td>25W</td>
<td>/</td>
<td>/</td>
<td>Syncope with trauma</td>
<td>5</td>
<td>Pause 7.5 sec.</td>
</tr>
<tr>
<td>DLA</td>
<td>F</td>
<td>78</td>
<td>Dyslipidemia</td>
<td>Flutter</td>
<td>CTI</td>
<td>40 W</td>
<td>/</td>
<td>/</td>
<td>Syncope with trauma</td>
<td>7</td>
<td>AV node rhythm &lt; 35 bpm</td>
</tr>
<tr>
<td>SM</td>
<td>M</td>
<td>79</td>
<td>A. Val. Disease</td>
<td>Flutter</td>
<td>CTI</td>
<td>40 W</td>
<td>/</td>
<td>/</td>
<td>asthenia + dyspnea</td>
<td>6</td>
<td>AVB III</td>
</tr>
</tbody>
</table>

**Abbreviations:** A= aortic; Abl= ablation; AVB= atrio-ventricular block; Comp= complications; Circ= circumferential; CTI= cavo-tricuspid isthmus; M= mitral; MD= mellitus diabetes type II; PAD= peripheral artery disease; PAF= parosiscastic atrial fibrillation; PHD= pulmonary heart disease; PV = pulmonary disease; SAB= sinus atrial block; TEA= thromboendarterectomy; TIA= transient ischemic attack.
the endocardial stimulation of autonomic ganglia which leads to immediate vagal response, such as RR decline, asistole and AV block. These responses disappear after isolation of pulmonary veins [10]. AV advanced block, sometimes irreversible, is one of the complications after ablation of cavotricuspid-isthmus-dependent atrial flutter. It is caused by direct RF injury to the septal, or abnormal flogistic response in the area near AV node, or an acute occlusion of the right coronary artery [11]. Instead the reversible block is caused by an increased vagal tone due to pain or stimulation of epicardial vagal fibres or ganglia. To our knowledge the arrhythmias, arisen during RF erogation, or until 30 days after the procedure, or until 60 days after ATC have a pathogenesis linked to the procedure (technique, time and power).

The patients described in this study are, just in appearance, affected by autonomic and independent ipokinetic arrhythmias. After a deep study, we found out that a RF-ATC was performed to treat refractory to pharmacological therapy supraventricular arrhythmias (4 AF and 2 Flutter) with a EHRA II-III class, a lot of months before the arising of the events. Definitive PM implantation was performed after 9.5 ± 4.7 months from the RF-ATC procedure. The brady-arrhythmias cannot be explain as a result of RF-ablation, because the late onset (9.5 ± 4.7 months) is too much to think to a isto-morpho-anatomic correlation.

This report consists of an heterogeneous group of 6 different arrhythmias: 6 cases of pAF and 2 cases of flutter, different ablated areas (the left atrial roof and ICT respectively) and technique used; all the pts shared RF-ATC and the late bradyarrhythmia onset.

A) Based on this observation we suggest three different hypothesis: "Electric remodelling as a result of ablation procedure"  
B) "Development of the natural history of AF"  
C) "Random observation".

D) RF erogated during ablation is responsible for a modification of the autonomic fibers and of the anatomic substrate. The close relation between pulmonary veins (PV) and ganglonated plexi shows that RF erogation causes not only pulmonary vein disconnection, but also a modification of the autonomic vagal tone [12]. Preganglionic parasympathetic vagal fibers to sinus atrial node, reach fatty tissue near PV, fibers to AV node terminate in fatty tissue near inferior vevan cava [13]. These areas, full of afferent vagal receptors, are ablated during the ATC procedure to treat AF and isthmo- cavo-tricuspid dependent Flutter. Furthermore, “C fibers”, which induce bradycardia and hypotension, are located in the ostium of the 4 PV, in the roof of left atrium, in the lateral right atrium and in the left posterior ventricle [14]. The RF erogation, basing on power and timing, induces a flogistic reaction characterized by interstitial oedema, microhemorrhage with coagulative necrosis, a flogistic cellular response which resolve in fibrotic tissue; this response depend on the characteristic of the pt. RF erogation could create a subclinical injury on autonomic cardiac fibers, although not so important to induce early bradyarrhythmias, on anatomic substrate with modifications that induce late atrial conduction for AF (increased critic mass) and late atrium-ventricular conduction (Bundle of His A-H-V-V); as a result of this modification could be lose the physiological ability to maintain SR [15-16].

E) The late onset of the arrhythmias, months after the ATC procedure, could be the evolution of the natural history of the complex arrhythmia AF, due to degenerative sclerotic myocardium. It is described the close relation between AF and sick sinus syndrome (SSS): it is caused by both, the reduced ability of the sinus node to rule and synchronize electric heart activity and the electric-anatomic atrial remodeling in AF [17-21]. Bradycardia due to SSS and structural (critical mass), electrical (focus, rotors, triggers), functional (Autonomic Nervous System) modifications support the tachyarrhythmia onset with RR variability. The RF-ATC aims to eliminate primary source and ectopic focus of AF and their spread, altering atrial structure. The suppression of the arrhythmia could let the sick sinus node to rule again. Can be a degenerative fibrotic sick node the physiological pacemaker? This phenomenon, also diffused to AV node, could explain the onset of bradyarrhythmias of our patients.

F) The third hypothesis is the possibility of “accidental coincidence” or “random observation”.

These arrhythmias could not have connections with AF disease and could not be the consequence of a previous procedure technique. They could be just an accidental observation due to an accurate follow-up after ATC. The arrhythmias after ATC developed in 11 % of our population, versus 2% of the percentage linked to a random observation.

So it is difficult thinking to an absence of linkage between the previous ablative procedure and the onset of the arrhythmia.

CONCLUSION

SSS and AV node disease developed in our 6 pts cannot be direct complications of RF-ATC, on the contrary of the early or late bradyarrhythmias described in literature. Io our opinion these arrhythmias are caused by the unsuccessful heart to maintain an artificial balance after ATC. The histological heart remodeling after the inflammation and an unbalance on ANS induced by RF enhance “critic mass”. Sometimes, the inability to find a good balance between these factors, determines the onset of arrhythmias in special pts.

An accurate analysis of the individual anatomy and of the risk factors, associated with a limited RF energy erogation is not able to prevent this specific response. Instead a deep follow-up after ATC could prevent permanent injuries and this kind complication.

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