Atrial Flutter After Radiofrequency Ablation for Barrett’s Esophagus: A Case Report

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Patient: Male, 74-year-old
Final Diagnosis: Atrial flutter • Barrett’s esophagus
Symptoms: Palpitations • dyspnea • chest pain
Clinical Procedure: Atrial flutter ablation • laparoscopic Nissen fundoplication • radiofrequency ablation (RFA) procedure with the Barrx™ catheter system
Specialty: Cardiology • Gastroenterology and Hepatology

Objective: Rare coexistence of disease or pathology

Background: Barrett’s esophagus (BE) is a metaplastic change in the normal esophageal squamous epithelium and is a well-recognized precursor of esophageal adenocarcinoma (EAC). Nowadays, focal radiofrequency ablation is a valid technique for BE treatment by inducing a superficial and focal thermic destruction of metaplastic tissues. According to the literature, the most frequent patient-related adverse events of this procedure are esophageal iatrogenic stenosis, mucosal laceration or perforation of the esophagus, chest pain, and odynophagia/dysphagia. Postoperative heart rhythm abnormalities have been reported very rarely.

Case Report: A 74-year-old patient with HE was treated by radiofrequency ablation (RFA) with the Barrx™ catheter system. He had 2 symptomatic episodes of atrial flutter in the immediate postoperative period requiring an external electrical cardioversion to induce a return to sinus cardiac rhythm. After atrial flutter ablation, 2 more radiofrequency procedures were performed, without adverse events. A laparoscopic Nissen fundoplication was carried out with complete endoscopic and histologic eradication of BE after 12-month follow-up. To the best of our knowledge, this is the first reported case of atrial flutter after esophageal RFA. Different mechanisms acting on an anatomic predisposing substrate can potentially play a role in starting atrial flutter, and include inflammation, autonomic activation, and myocardial injury.

Conclusions: The occurrence of this new type of adverse effect could potentially modify indications and postoperative monitoring of RFA treatment for BE. Endoscopists should know the possibility of this procedural complication in high-risk patients and they should propose alternative techniques or implement close cardiac monitoring in the postoperative period.

Keywords: Atrial Fibrillation • Atrial Flutter • Barrett Esophagus • Catheter Ablation • Radiofrequency Ablation

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Background

Barrett’s esophagus (BE) is a change in the epithelial lining of the esophagus and is a precursor condition for esophageal adenocarcinoma (EAC). BE develops as a result of chronic exposure to refluxed stomach acids, enzymes, and bile. It occurs when a patient’s lower esophageal sphincter or valve fails to close properly, thus not preventing acid backwash into the lower esophagus. This results in recurrent mucosal injury that is accompanied by inflammation, and ultimately metaplasia to intestinal epithelium, associated with risk of cancer transformation. The steps between normal esophageal tissue and cancer are described as normal squamous epithelium – intestinal metaplasia – low-grade dysplasia – high-grade dysplasia – cancer (mainly adenocarcinoma) based on histological analysis [1] and classified according to Prague circumferential (C) length and maximal (M) length criteria [2] after endoscopic examination. Therefore, once diagnosed, the current recommendation is to establish endoscopic surveillance to identify early dysplasia and neoplasia that could be treated by endoscopic eradication therapy.

Focal radiofrequency ablation is a valid technique for BE treatment by inducing superficial and focal thermic destruction of metaplastic tissues [3]. The use of sizing balloons is required to determine the inner diameter of the targeted portion of the esophagus. This is followed by placement of a balloon-based electrode with a 3-cm-long treatment area incorporating tightly spaced bipolar electrodes that alternate in polarity. The electrode is then attached to a radiofrequency generator and a preselected amount of energy is delivered in less than 1 s at 350 W. The procedure drives focal mucosal destruction. New esophageal squamous tissue regenerates, decreasing the risk of cancer transformation. The technique has good long-term results, maintaining normal esophageal mucosa with no recurrence of BE in 75% to 92% of patients at 3 years [4,5]. The rate of adverse effects of RFA is low and mainly involves post-procedure chest discomfort or odynophagia, upper-gastrointestinal hemorrhage (<1%) [3], post-procedure nausea or vomiting, or late esophageal stricture endoscopically identified after 3 years (6-13.3%) [3,4,6]. Here, we report the case of 1 patient who had an atrial flutter that was an uncommon radiofrequency ablation-linked complication.

Case Report

The present case report was developed according to the Consensus-based Clinical Case Reporting Guideline (CARE checklist) [7]. A 74-year-old man was referred to Nouvel Hôpital Civil in Strasbourg (France) for a non-dated Barrett’s esophagus discovered in February 2021 during a gastroscopy, performed to investigate chronic anemia. His past medical history included pericarditis in 1994, type 2 diabetes treated with oral medications, prostate cancer treated by total prostatectomy in 2004, narcolepsy-cataplexy syndrome, and chronic angina pectoris cured by a mono-troncular stent in the right coronary artery in October 2015. There was no dysplasia when BE was discovered. The patient has been treated first with a high-dose proton pump inhibitor (esomeprazole 40 mg 2 times daily), and at an endoscopic control in May 2021 showed a BE of an 8-cm-long circular section (C), measured from the proximal cardial notch, and an additional short tongue of 1 cm, C8M9 according to Prague C&M classification [2], with no dysplasia. At 1-year endoscopic control in September 2021, a progression to C8M12 BE with a low-grade dysplasia was found. After a multidisciplinary meeting, we decided to perform radiofrequency ablation to achieve local control of the dysplastic area.

In December 2021, we performed a non-circumferential Barrx Halo90 (Barrx Medical, Sunnyvale, Calif) radiofrequency ablation (RFA 12 J/300 W). The endoscopic procedure was performed...

Figure 1. RFA using the Halo® 90 electrode fitted on the tip of a forward viewing endoscope for non-circumferential Barrett’s ablation.
under general anesthesia with endotracheal intubation. Propofol was the sedative used to induce anesthesia. The esophageal epithelium was first irrigated with acetylcysteine (1%), a mucolytic agent, via a spray-tip catheter. The endoscope was removed, and the sizing balloon was calibrated and inserted over the guidewire to ensure uniform contact between the RFA electrode and the esophageal mucosa. A 22-mm ablation catheter was introduced under endoscopic control. The electrode was then activated with energy settings of 12 J/m² and 300 W/cm², thus completing the ablation procedure (Figure 1). After removing the balloon and endoscope and cleaning the electrode, the endoscope was reintroduced and used to remove adherent coagulum from the ablation zone (Figure 2). The procedure was then repeated once more.

The patient was monitored for 2 h after recovering from general anesthesia. A 12-lead electrocardiogram revealed a saw-toothed pattern of inverted F waves in the inferior leads II, III, and aVF associated with biphasic F waves in I and aVL, an upright F wave in V1, and an inverted F wave in V6 with an atrial cycle length of 200 ms. This electrocardiographic surface was diagnostic for a typical type I atrial flutter (Figure 3).

The episode was symptomatic but well tolerated with dyspnea but no chest pain or palpitations. Monitoring was performed with serial electrocardiograms and 24-h Holter monitor. Atrial flutter was first treated by intravenous amiodarone, a class III antiarrhythmic, at a dosage of 150 mg over a period of 10 min, followed by a 1 mg/min infusion for 6 h, and then by an infusion at 0.5 mg/min for 24 h. Intravenous therapy was finally switched to oral administration of amiodarone 400 mg daily. This management allowed us to regain sinus cardiac rhythm. We started a curative anticoagulation treatment by heparin. Two days after the procedure, on 10 December, a new atrial flutter episode occurred. This second event was characterized

![Figure 2. Treatment zone after ablation with peripheral exudative material caused by the burn.](image)

![Figure 3. Electrocardiographic manifestations of type I atrial flutter 2 hours after RFA.](image)
by more pronounced symptoms with palpitations, chest pain, and dyspnea. Medical treatments were not effective, and an external electrical cardioversion was necessary to induce return to sinus cardiac rhythm. The patient was discharged on 22 December 2021, with an antiarrhythmic treatment, including bisoprolol 10 mg/day and amiodarone 200 mg/day, and atrial flutter ablation was planned. After atrial flutter ablation, 2 more radiofrequency procedures were performed to treat BE, and both were free of adverse events. Endoscopic control in March 2022 found lower-esophageal ulceration, but no findings of BE. A laparoscopic Nissen fundoplication was performed. Endoscopic follow-ups in January and March 2023 were normal, with complete endoscopic and histologic eradication of BE after 12-month follow-up.

Discussion

According to the literature and our experience, the most frequent adverse event of RFA is esophageal stenosis, with the longitudinal tumor being the most significant predictive factor. Early intervention with dilatation or prevention for structure should be applied for patients with a segment longer than 8-9 cm. When dilatation fails, resulting in recurrent strictures, new alternative techniques are considered, including endoscopic incisional therapy, esophageal stents, or intraluminal injection of steroids or mitomycin C.

Atrial flutter has not previously been reported as a complication after the radiofrequency procedure with the Barrx™ system used in BE treatment. A recent report by Dubrouskaaya et al [8] analyzed the adverse events and device malfunctions linked to the use of all available catheters compatible with the Barrx™ system using data from the Food and Drug Administration’s (FDA) Manufacturer and User Facility Device Experience (MAUDE) database from August 2011 to August 2021. The study showed that the most frequent patient-related adverse events were esophageal stenosis secondary to treatment, mucosal laceration or perforation of the esophagus, chest pain, and odynophagia/dysphagia. No cases of heart rhythm abnormalities emerged from the MAUDE database. Similarly, a systematic review and meta-analysis by Qumseya et al [9] evaluated the rate of adverse events associated with RFA, with and without EMR, through the analysis of 37 studies totaling 9200 patients. The only complications reported were strictures, perforation, bleeding, and pain. One case of asymptomatic atrial fibrillation was mentioned in a 2018 pilot study by Belghazi [10] including 30 patients, where the other mild to moderate adverse events were mucosal laceration, vomiting and dysphagia, and dysregulated diabetes. Another case of atrial fibrillation was reported in 2010 by dos Santos et al in a preliminary study including 14 patients treated with RFA associated with anti-reflux procedure for Barrett’s metaplasia and low-grade dysplasia. The close anatomical relations between esophagus and atrial chambers could explain the association between radiofrequency ablation and supraventricular tachyarrhythmias. The exact relationship varies widely; in some patients, the esophagus is close to the left pulmonary vein, while in others cases it is close to the right pulmonary vein. The posterior wall of the left atrium and the esophagus are separated by a tissue layer about 5 mm thick. Esophageal vessels, lymph nodes, and the paraesophageal nerve plexus are located within this exiguous space. The energy delivered by the electrode results in high-temperature heating of the Barrett’s lining.

Atrial fibrillation is generally recognized as a result of chaotic atrial rhythm involving multiple micro-reentrant circuits within the atria, whereas atrial flutter is a more organized macro-reentrant rhythm. About 20 years ago, Prof Philippe Coumel, the founding father of modern arrhythmology, introduced the Coumel’s triangle concept, a milestone in understanding arrhythmogenic mechanisms [11]. According to this arrhythmogenic substrate, modulating factors and triggering factors play the main role in atrial fibrillation pathophysiology. Although the underlying trigger mechanisms are speculative, different mechanisms can potentially play a role in starting both atrial flutter and/or atrial fibrillation, acting on an anatomic predisposing substrate. These mechanisms mainly include inflammation, autonomic activation, and myocardial injury and may explain the possible mechanisms of RFA-induced arrhythmia, as explained in detail below.

Autonomic Activation

Several stimuli (chemical, electrical, or mechanical) can modify sympathovagal balance causing arrhythmogenic substrates for re-entry, promoting atrial arrhythmias susceptibility [12]. In particular, the autonomic nervous system with adrenergic activation may start focal activity by 3 main principal cellular mechanisms: enhanced automaticity, early afterdepolarization, or delayed afterdepolarization-associated triggered activity. A link between cardiac arrhythmias and gastro-enteric stimuli (RFA included) involving the distal esophagus has been proven, given the close anatomical proximity between the esophagus and the left atrium. Acid reflux increases vagal activity, causing local inflammation directly entering the esophageal wall. This stimulates the adjacent vagal nerves, creating an arrhythmogenic substrate for re-entry circuits and increasing susceptibility to AF [13].

Inflammation

An inflammatory reaction resulting from radiofrequency ablation could involve anatomical structures by contiguity, propagating from the esophageal wall to the pericardium, to the atrial myocardium. Moreover, inflammatory cytokines may
induce afferent-efferent reflex mechanisms, changing atrial electrophysiology and structural substrates, thereby leading to increased vulnerability to atrial fibrillation [14].

In particular, presence of systemic inflammation with elevations in C-reactive protein (CRP) and interleukin 6 (IL-6) is linked to a significant risk for future development of AF. An increase in inflammatory cytokines in the atrial tissue results in a local complement system activation leading to „atrial myocarditis“. The exact underlying mechanism is the cellular membrane dysfunction caused by CRP binding to phosphatidylcholine in the presence of Ca2+ ions. This generates a transmembrane ion transport malfunction with consequent electrical changes in the atrium [15].

Not only CRP, but also high plasma IL-6 levels are associated with AF occurrence and duration and an increased left atrial diameter. Furthermore, a genetic susceptibility could explain an enhanced inflammatory response with subsequent development of AF [16]. This theory is supported by evidence of a link between inflammatory bowel disease and the presence of electrocardiographic P-wave dispersion that is a risk factor for cardiac arrhythmias [17].

Myocardial Injury

In addition to the possible direct action of radiofrequency ablation, esophageal stimulation can cause anginal attacks and significantly reduce coronary blood flow in patients with coronary artery disease. The lack of this effect in heart transplant recipients with complete heart denervation suggests the involvement of a neural reflex [18]. This can be understood in the context of the “esophagocardiac reflex,” which describes how esophageal chemical and mechanical stimulation in patients with documented coronary artery disease results in typical chest discomfort and a significant reduction in coronary blood flow. Reduced cardiac perfusion, increased microvascular resistance, and enhanced vasoconstrictor response may affect the atra, leading to substrates for atrial arrhythmias.

A high level of suspicion is needed for early diagnosis of cardiac arrhythmia after radiofrequency ablation for BE, as it is a rare complication. It seems reasonable to not propose radiofrequency ablation to patients with either history or high risk of heart rhythm disorder (heart failure, dilated cardiomyopathy, mitral valvular disease). Indeed, there are many other effective techniques to treat BE without using focal energy or electric current (eg, cryotherapy, endoscopic mucosectomy, dynamic phototherpay, and argon coagulation). Another important aspect to consider is the clinical effect of sedation-related adverse events (SRAE) during RFA. An interesting report focused on this topic found that the occurrence of an SRAE was a stronger predictor of increased RFA sessions than either Barrett’s length or hiatal hernia, which are the 2 most important factors for predicting response to treatment [18]. Moreover, it has been widely proven that propofol, the most commonly used sedative drug for induced anesthesia, has arrhythmogenic features due to its effects on cardiac electrical activity. Tascanov et al [19] investigated the effect of propofol on myocardial depolarization and repolarization during sedation induced for colonoscopy. The study showed that propofol significantly prolonged the frontal QRS-T angle, which had important prognostic value in predicting cardiovascular arrhythmias and is also associated with increased risk of arrhythmic death.

It is therefore clear how radiofrequency ablation used for BE treatment requires close supervision of heart rhythm during the entire hospital stay. In our patient, the atrial flutter occurred a few hours after the procedure and relapsed 2 days after. To prevent this type of complication, we could suggest to patients that they receive continuous heart monitoring after this procedure until they leave the hospital. The exact details of heart supervision after radiofrequency ablation remains unknown because of the small number of reported cases and the only hypothetical physiopathology of the electrical process induced by radiofrequency ablation in atrial flutter.

Conclusions

RFA with the Barrx™ catheter system is widely used for the treatment of BE. To the best of our knowledge, this is the first case of symptomatic atrial flutter reported in the literature after RFA with the Barrx™ system. Although cardiac rhythm disturbances are an extremely rare complication of the procedure, endoscopists should be aware of the possibility of this occurrence and a category of high-risk patients should be identified based on the underlying mechanisms for whom RFA would be contraindicated.

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