Successful Nonsurgical Treatment of Esophagopericardial Fistulas After Atrial Fibrillation Catheter Ablation

A Case Series

Charlotte Eitel, MD*; Sascha Rolf, MD*; Markus Zachäus, MD; Silke John, MD; Philipp Sommer, MD; Andreas Bollmann, MD, PhD; Arash Arya, MD; Christopher Piorkowski, MD; Gerhard Hindricks, MD; Ulrich Halm, MD

Background—Esophageal perforations are a rare but devastating complication of atrial fibrillation catheter ablation. Rapid treatment is crucial to avoid permanent disabilities and death. Surgical treatment is considered the treatment of choice. Alternatively, single case reports describe successful esophageal stenting, but others discourage this approach because of fatal consequences.

Methods and Results—We present 3 patients who developed esophagopericardial fistulas after radiofrequency catheter ablation of atrial fibrillation. Diagnosis and management with pericardial drainage and esophageal stenting, as well as long-term follow-up are described. Esophagopericardial fistulas occurred 26, 9, and 18 days after the ablation procedure. Symptoms leading to admission were recurrence of atrial fibrillation (n=1), elective control endoscopy for thermal lesion (n=1), and pain with swallowing (n=1). Computed tomography revealed esophagopericardial fistulas with pericardial effusion in all patients, while contrast leakage and air in the left atrium could be excluded. Broad-spectrum antibiotics were initialized, and minimally invasive pericardial drainage and esophageal stenting were performed. Stent dislocation occurred in 2 patients and was resolved by repositioning and clipping of the proximal stent end. After 45, 22, and 28 days, respectively, fistulas appeared closed and stents were removed. During follow-up, no embolic or septic events occurred. However, 2 patients underwent dilation of symptomatic esophageal stenosis in the formerly stented region.

Conclusions—An early minimally invasive approach consisting of pericardial drainage and esophageal stenting proved effective in treating patients with esophagopericardial fistulas. However, constant interdisciplinary communication and attention is needed to recognize and manage potential evolving complications promptly. (Circ Arrhythm Electrophysiol. 2013;6:675-681.)

Key Words: adverse events complication • atrial fibrillation • catheter ablation • esophageal perforation • fistula • pericardial effusion • stenting

Esophageal perforations are one of the most feared complications of atrial fibrillation (AF) catheter ablation. The incidence is estimated to range from 0.04% to 0.2%, but potential underestimation because of nonspecific symptoms and delayed occurrence has to be taken into account. The close vicinity of the posterior left atrium and the anterior esophagus predisposes this region to be injured. Rather than a single factor, a combination of multiple factors such as thermal injury of the esophagus, ischemic injury through occlusion of end arterioles, acid enzymes, and infection from the lumen are supposed to result in delayed fistula formation. Rapid diagnosis and treatment are crucial to avoid permanent disability and death, as delayed diagnosis with manifestation of neurological symptoms because of air embolism and sepsis dramatically worsens prognosis.

Because of the low prevalence of this complication, there is no gold standard for treatment. Instead, several case reports and series indicate that surgical treatment is mandatory. Alternatively, successful stenting of an esophageal perforation without communication with the atrium or the pericardium has been described. Advantages from stenting arise from quick establishment of a barrier that minimizes air and solid material embolism without the risks of esophageal surgery. However, other reports describe fatal complications caused by air insufflation during upper gastrointestinal endoscopy or stent dislocation leading to insecurities of adapting this approach in patients with esophageal perforations.

We report a series of patients with esophagopericardial fistulas after radiofrequency catheter ablation for AF, who could be successfully managed with a nonsurgical treatment approach by both sealing up the entrance of the fistula with

Clinical Perspective on p 681
a fully covered esophageal stent and controlling the pericardial infection by drainage together with antibiotic treatment. Advantages and hazards of this approach are discussed.

**Methods**

Diagnosis and management of 3 patients with esophagopericardial fistulas after radiofrequency catheter ablation of drug-refractory highly symptomatic AF are described.

**Ablation Procedure**

Patients were studied under deep propofol sedation as described previously.13 Mapping and ablation were performed under the guidance of 3-dimensional (3D) mapping systems supplemented by 3D image integration.13 All patients underwent wide circumferential pulmonary vein (PV) isolation with additional lesions at the discretion of the treating electrophysiologist as described previously.14,15 The intervention was performed with an open-irrigated radiofrequency ablation catheter. Standard ablation settings consisted of a maximal tip temperature of 48°C, a flow rate of 30 mL/min, and a power of 25 to 40 W. At the posterior wall standard power setting was 25 W. For initial linear ablation, the catheter tip was dragged along the intended lesion, until local electrogram reduction was recorded after ≈20 to 30 seconds at each site. A temperature probe (Sensitherm, St. Jude Medical, St. Paul, MN) within the esophagus was used to visualize its course and to monitor luminal esophageal temperature.16 Transient increases of power delivery up to 35 W at the left atrial posterior wall were allowed unless esophageal temperature increased to >41°C. In case of significant temperature rise (>41°C), energy application was reduced for subsequent radiofrequency applications. In addition, ablation in contact areas between the left atrium and the esophagus as visualized on fluoroscopy and mapping system was avoided. All patients were discharged with a proton-pump-inhibitor.

**Diagnostic Work-Up and In-Hospital Management**

Laboratory parameters, vital signs, and temperature were regularly assessed. Broad-spectrum antibiotics and high-dose proton-pump-inhibitors were given until the stents were removed. Pain medication was given generously to achieve freedom from chest pain. All patients underwent thoracic computed tomography (CT) with intravenous and oral contrast. Puncture of the pericardial cavity was given generously to achieve freedom from chest pain. Inhibitors were given until the stents were removed. Pain medication was given generously to achieve freedom from chest pain.

All patients underwent thoracic computed tomography (CT) with intravenous and oral contrast. Puncture of the pericardial cavity was performed under fluoroscopic guidance with the use of contrast agent and a pigtail catheter was placed by means of the Seldinger technique. The pigtail catheter was left in place for 5 to 7 days for continuous drainage and repeated flushing with saline. Transthoracic echocardiography was performed for follow-up of pericardial effusion and chest x-rays were performed to control location of esophageal stents.

Patients received fluid alimentation for 2 days, followed by soft diet until stent removal.

**Endoscopy**

Because of the vicinity of the endoscopy unit, upper gastrointestinal endoscopy with stent placement could be performed without time delay. Patients underwent endoscopy under conscious sedation with the use of midazolam and propofol. Noninvasive blood pressure, pulsoxymetry, and heart-rate monitoring were done according to a standardized protocol. The esophagus was carefully inspected using standard video endoscopes (Olympus, Hamburg, Germany). The esophageal opening of the fistula was identified as an ulcer-like lesion in the lower part of the esophagus. A guidewire was inserted in the stomach through the endoscope. After removal of the endoscope, a fully covered esophageal stent was inserted via the guide wire. The endoscope was reinserted and the stent was released under direct endoscopic control.

**Follow-Up**

After discharge patients were routinely followed up in our outpatient clinic and finally contacted by telephone in December 2012 to assess long-term outcome.

**Results**

Three patients were diagnosed and treated for esophagopericardial fistulas after radiofrequency catheter ablation of paroxysmal (patient 2) or persistent AF (patients 1 and 3). Clinical characteristics of the patients are detailed in the Table.

Patients 1 and 2 underwent ablation at our institution in February 2011 (patient 1) and February 2012 (patient 2), whereas patient 3 was referred from an outside hospital after undergoing AF ablation in May 2012. With 1051 AF ablation procedures in our hospital in 2011 and 1061 in 2012 this leads to a prevalence of 0.1% per year.

Circumferential PV isolation had been performed in all patients with additional ablation of a right atrial ectopic tachycardia in patient 1. Maximum temperature within the esophagus was not documented in patient 1 (esophageal course B,16 near to the left PVs), whereas in patient 2 temperature shortly reached 44°C (esophageal course B,16 near to the left PVs). Details of esophageal course and temperature monitoring in patient 3 are lacking, as this patient underwent ablation in another hospital. The treating operator reported that temperature monitoring was not conducted, but that extensive ablation along the posterior wall of the left atrium was performed.

**Patient 1**

An 85-year-old female patient was admitted 23 days after catheter ablation for persistent AF for electric cardioversion of highly symptomatic atrial flutter. She was afebrile with no signs of infection. Because of ineffective anticoagulation, transesophageal echocardiogram was performed for exclusion of left atrial thrombi before successful electric cardioversion. Consecutively, arrhythmia-related symptoms (dyspnea, palpitations, and fatigue) completely resolved. However, the next day the patient started complaining of non-specific symptoms like malaise, moderate dyspnea that further worsened on day 3 after admission going along with hypotension and an increase of inflammation parameters (Leukocytes 12.4 Gpt/L; C-reactive protein 221.9 mg/L). Transthoracic echocardiogram revealed a significant pericardial effusion and periocardiocentesis was performed urgently with aspiration of 350 mL of cloudy fluid and air (Figure 1A). A pigtail catheter was placed in the pericardium and a CT scan of the thorax and the brain performed emergently confirming a fistula between the pericardium and the esophagus near the left PV ostium (Figure 1B). Free air in the left atrium could be excluded, as well as embolic lesions of the captured abdominal organs and the brain. Because of the high surgical risk of this patient we decided to place an esophageal stent. Upper gastrointestinal endoscopy revealed an esophageal perforation of 5 mm (Figure 1C). A self-expandable fully coated metal stent (Leufen Medical, Aachen, Germany; length 10 cm, diameter 34 mm) was successfully placed 3 cm above the cardia with complete covering of the fistula (Figure 1D). Subsequently the patient’s condition improved and signs of infection declined. A repeat CT scan 3 days after stent placement confirmed no further contrast extravasation (Figure 1E). The patient’s course was unremarkable during the following weeks, so that she could be discharged after 26 days. After 45 days, endoscopy with removal of the stent was performed and complete healing of the previous perforation could be documented (Figure 1F).
Patient 2

Upper gastrointestinal endoscopy in this 68-year-old male patient was performed the day after the ablation procedure because of a significant temperature increase in the esophagus of 44°C. This temperature peak was reached because of a deferred reaction to stop energy delivery and a delayed overshoot in esophageal temperature >41°C. A 6×12 mm ovular thermal lesion (Figure 2A) was seen 32 cm from incisors. The patient was discharged with high-dose proton-pump-inhibitors (pantoprazole 40 mg twice daily) and an appointment was fixed for a control endoscopy at our hospital 3 days later. The patient canceled this appointment and underwent outpatient control endoscopy 9 days post discharge. The external gastroenterologist now suspected an esophageal fistula and emergently readmitted the patient to our hospital. CT demonstrated leakage of contrast media from the esophagus to the mediastinum and mediastinal air, but esophagoatrial fistulation could be excluded. Subsequently, upper gastrointestinal endoscopy was performed and a fully coated metal stent (Leufen Medical, Aachen, Germany; length 10 cm, diameter 34 mm) placed over the progressive ulcer (maximal diameter 10 mm). Because of aggravating chest pain refractory to analgetics, a control endoscopy was performed 10 days after stent implantation. Deep ulcerations at the proximal and distal stent because of the upper and lower margins of the stent, respectively, were seen. The thermolesion itself now looked plain and healing. Therefore, the stent was removed. Consequently, inflammation parameters rose (Leukocytes 20.7 Gpt/L; C-reactive protein 14.3 mg/L), so that control endoscopy was performed after another 4 days now revealing esophageal fistulation. During endoscopy the patient became hemodynamically unstable because of pneumopericardium (Figure 2B), which was relieved with pericardial puncture. An attempt was made to close the fistula with an over-the-scope clip (Ovesco, Tübingen, Germany), but the clip had to be removed because of incomplete closure of the fistula as controlled by endoscopy. Finally, 12 days after removal of the first stent, a new esophageal stent (Tae Woong, Mandel & Rupp, Erkrath, Germany; length 10 cm, diameter 28 mm) was inserted. The following day hematemeses occurred. Endoscopy revealed stent dislocation and a Mallory-Weiss tear as the source of bleeding. The tear was closed by conventional hemoclips and the stent repositioned and fixated at the proximal end with a conventional clip. The stent and the clips were removed 22 days later and endoscopy demonstrated healing of the esophageal fistula. After 2 months the patient presented with progressive dysphagia. Endoscopy revealed esophageal stenosis in the region of the prior Mallory-Weiss tear, so that bougienage ≤14 mm was performed. No further dysphagia occurred during follow-up of further 4 months.

Patient 3

A 69-year-old female patient was admitted to our hospital for suspected esophagopericardial fistula. Ablation had been performed in another institution. The patient reported progressive difficulties in swallowing and retrosternal pain starting the day after the ablation procedure and resulting in readmission to another hospital 13 days post ablation. Water-soluble contrast swallow and CT showed a niche with contrast within the esophagus, but without signs of contrast leakage. Upper
gastrointestinal endoscopy was performed showing a circular esophageal lesion of 1 cm covered with fibrin. The patient was set in a fastened state and intravenous proton-pump inhibitors, as well as antibiotics, were started. Parameters of inflammation and complaints stabilized, until 4 days later the patient complained of sudden onset of violent persisting pain after drinking water. Endoscopy now revealed esophageal fistulation with a diameter of 8 mm and contrast swallow and CT confirmed esophagopericardial fistula near to the inferior left PV. Therefore, the patient was immediately transferred to our hospital. Pericardial puncture was performed with aspiration of 150 mL cloudy exsudate and 80 mL air. The pigtail catheter was left in place and endoscopy was performed. Endoscopy in our unit showed a fistula with a diameter of 8 mm with purulent secretion. A fully covered self-expandable nitinol stent (Tae Woong, Mandel & Rupp, Erkrath, Germany; length 10 cm, diameter 30 mm) was implanted with complete covering of the fistula. Control endoscopy the next day revealed stent dislocation of 2 cm. Therefore, repositioning and fixation of the proximal stent with 2 clips were performed. Follow-up x-ray (Figure 3) and CT did not show any dislocation of the stent in the following weeks. After 28 days the stent was removed and endoscopy now showed a fibrin covered esophageal lesion with hypergranulation in the region of the proximal and distal stent. Further control endoscopies were performed 2 and 6 weeks post discharge showing a niche in the region of the prior lesion initially, which completely healed by 6 weeks. However, the patient underwent endoscopic dilation of a circular stenosis at 28 cm (region of the proximal stent tulip) for dysphagia. Afterward dysphagia resolved and there were no further interventions necessary.

Discussion
To our knowledge this is the first series of patients with esophagopericardial fistulas as a consequence of AF catheter ablation that could be successfully managed nonsurgically. Early diagnosis before the onset of neurological symptoms and exclusion of esophagoatrial communication is crucial to adapt an approach consisting of aggressive antibiotic treatment, pericardial drainage, and esophageal stent placement. This minimally invasive approach facilitates rapid stabilization of patients and can even serve as definite treatment of a complication that until now was commonly thought to be definitely healed only by surgery. However, close interdisciplinary collaboration and awareness is needed to recognize and manage potential evolving complications promptly.

Prevention of Esophageal Injury During AF Catheter Ablation
Description of esophageal perforation after AF catheter ablation resulted in great efforts to prevent this potentially life-threatening complication. The rare prevalence of this complication, however, hampers the evaluation of these various methods.
in preventing esophageal perforations. On the basis of the assumption that esophageal damage precedes development of esophageal perforation and fistulation, recent studies assessed the frequency of esophageal thermal lesions as detected by endoscopy when preventive measures are applied. These range from assessment of esophagus position to temperature monitoring, mechanical displacement of the esophagus, modulation of power and time, and prophylactic treatment with proton-pump-inhibitors. Data of our own group indicate that the maximum temperature measured by an esophageal temperature probe is highly predictive of esophageal injury with no esophageal perforations may occur, despite temperature monitoring, because of limitations of the monitoring strategy itself or prophylactic treatment with proton-pump-inhibitors. Data of our own group indicate that the maximum temperature measured by an esophageal temperature probe is highly predictive of esophageal injury with no esophageal lesion occurring when the maximum intraluminal temperature was <41°C. Nevertheless, even when preventive measures are applied, occurrence of esophageal perforation has been described. Likewise in our series, esophagopericardial fistula occurred in patient 1 in whom no significant temperature rise was documented. On critical retrospective analysis, failure to comply with our own clinical protocol consisting of adequately adjusting the temperature probe may have been the most likely reason. In the end, this case further highlights that esophageal perforations may occur, despite temperature monitoring, because of limitations of the monitoring strategy itself or its application. Unfortunately, data on temperature monitoring in patient 3 are completely lacking, whereas patient 2 exhibited a significant temperature increase.

In patients 2 and 3, initial endoscopy revealed thermal esophageal injury and development of esophagopericardial fistula was not seen until control endoscopy. These observations strengthen the suggestion that esophageal injury precedes fistula formation, which in our cases and as previously described could be stopped at the level of esophagopericardial fistula. However, the exact factors which determine progression to esophageal fistula are unknown. Although patient 2 experienced esophagopericardial fistula, despite preventive measures, the fact that a significant temperature increase had been observed during ablation resulted in early detection of the fistula. This is especially true as patient 2 was asymptomatic and exclusively underwent control endoscopy because of the results of temperature monitoring.

**Diagnosis of Esophagopericardial Fistulas**

Early diagnosis seems to be a prerequisite for successful treatment of this complication and prevention of fatal outcome. Unspecific symptoms require a first line knowledge and suspicion of this complication in patients who have undergone an ablation procedure. Late occurrence further hampers diagnosis, potentially resulting in further delay. Therefore, patient instruction to contact the interventionalist in case of worrisome symptoms is mandatory.

Differential diagnosis between esophagopericardial and esophagoatrial fistulas is based on clinical criteria. Esophagopericardial fistulas are characterized by nonspecific thoracic complaints resulting from pericardial effusion and pericarditis accompanied by signs of infection. In case of esophagoatrial fistulas again nonspecific symptoms, as well as severe chest or epigastric pain and fever combined with leukocytosis, have been described. Furthermore, direct connection of the esophageal lumen with the left atrium might result in additional severe complications such as embolization of air or food components, resulting in neurological complications or myocardial infarction and hematomasis or hemorrhagic shock caused by bleeding in the esophagus.

A CT with intravenous and water-soluble oral contrast should further be performed to exclude esophagoatrial communication, intravascular air, and potential embolic lesions, as in these cases performance of transesophageal echo or endoscopy should be avoided to prevent air insufflation with fatal consequences. Furthermore, pericardial effusion as detected by transthoracic echo or CT should raise suspicion of esophagopericardial communication.

**Treatment of Esophagopericardial Fistulas**

Although surgical treatment was thought to be mandatory to manage this complication successfully, single case reports describe successful treatment of esophageal perforation after AF catheter ablation with esophageal stenting. However, only patients with isolated perforation without pericardial or atrial communication have been successfully treated with this approach. In patients with esophagopericardial and esophagoatrial fistulas, fatal courses or the necessity of combining stenting with surgery have been described. Besides this, there is growing experience with esophageal stenting in the context of iatrogenic perforations because of endoscopic procedures. However, these series did not include patients with esophageal fistulation to the pericardium or the atrium.

In patients with symptoms of embolism or upper gastrointestinal bleeding suggesting esophagoatrial communication, an urgent surgical approach should still be considered,
whereas in patients with signs of pericarditis or pericardial effusion without the dramatic symptoms of esophagogastric fistula, an interventional therapeutic approach may be offered.

Our concept to combine esophageal stenting with pericardial drainage follows the consideration of both sealing up the entrance of the fistula with a fully covered esophageal stent and controlling the pericardial infection by continuous drainage and repeated rinsing of the pericardial cavity. This minimally invasive, nonsurgical approach combined with systemic antibiotic treatment was sufficient in all of our patients, with none of them experiencing recurrence of pericarditis.

Over time the value of placing a pericardial drainage before endoscopy became clear as air insufflation may result in pneumopericardium and hemodynamic instability, as happened in patient 2. Therefore, we would recommend to place a pericardial drainage initially after diagnosis is confirmed by CT and then insert an esophageal stent.

The high radial force on the relatively sharp-edged tulips of the primarily used stents caused severe chest pain and circular ulcerations of the esophageal wall. Despite the use of analgetics, the stent had to be removed in patient 2. However, stents shaped with a broader contact surface at the tulips may be better tolerated as shown in this patient.

Despite the special design of the stents with high radial forces and proximal and distal stent tulips, stent dislocation occurred. Other than in stenting of esophageal stenosis, migration of fully covered metal stents is a frequent problem. With the experience of our patients, we recommend the fixation of the proximal stent tulip with clips to prevent stent dislocation.

In 2 patients the ulcerations because of the tulips resulted in esophageal stenosis. However, these kinds of stenosis can successfully be treated with dilatation.

Study Limitations
This is a small series of patients treated in a high-volume center, where rapid communication among electrophysiologists, gastroenterologists, radiologists, and intensive care physicians and a high grade of awareness of this possible consequence facilitated prompt detection and treatment of complications, like pneumopericardium, stent dislocation, and hematemesis. The described approach has only been used for patients with early detected esophagopericardial fistulas and cannot be applied for patients with esophagoaortial fistulas.

Conclusion
A minimally invasive approach consisting of aggressive anti-biotic treatment, pericardial drainage, and esophageal stenting proved effective in treating patients with esophagopericardial fistulas. Early detection, rapid treatment, and constant awareness of potential fatal consequences are mandatory to treat this complication successfully.

Disclosures
C. Eitel, S. Rolf, and P. Sommer have received modest lecture honoraria and congress sponsoring from St. Jude Medical. C. Piorkowski has received modest lecture honoraria from St. Jude Medical and Biotronik and is a member of the St. Jude Medical advisory board. G. Hindricks has received modest lecture honoraria from St. Jude Medical, Biotronik, Medtronic and Biosense and is a member of the St. Jude Medical and Biosense advisory board. The other authors report no conflict.

References
Esophageal perforations are a rare but devastating complication of atrial fibrillation catheter ablation. Early diagnosis and rapid treatment are crucial to avoid permanent disabilities and death. We report diagnosis, nonsurgical management, and long-term follow-up of 3 patients with esophagopericardial fistulas after radiofrequency catheter ablation for atrial fibrillation. Patients were successfully treated by both sealing up the entrance of the fistula with a fully covered esophageal stent and controlling the pericardial infection by drainage together with systemic antibiotic treatment. This minimally invasive approach facilitates rapid stabilization of patients and can even serve as definite treatment of a complication that until now was commonly thought to be definitely healed only by surgery. In patients with signs of pericarditis or pericardial effusion without the dramatic symptoms of esophageal fistula, an interventional therapeutic approach may be offered. Constant interdisciplinary communication and attention is needed to recognize and successfully manage potential evolving complications promptly, such as pneumopericardium, stent dislocation, and hematemesis.

**CLINICAL PERSPECTIVE**

Esophageal perforations are a rare but devastating complication of atrial fibrillation catheter ablation. Early diagnosis and rapid treatment are crucial to avoid permanent disabilities and death. We report diagnosis, nonsurgical management, and long-term follow-up of 3 patients with esophagopericardial fistulas after radiofrequency catheter ablation for atrial fibrillation. Patients were successfully treated by both sealing up the entrance of the fistula with a fully covered esophageal stent and controlling the pericardial infection by drainage together with systemic antibiotic treatment. This minimally invasive approach facilitates rapid stabilization of patients and can even serve as definite treatment of a complication that until now was commonly thought to be definitely healed only by surgery. In patients with symptoms of embolism or upper gastrointestinal bleeding suggesting esophageal fistula communication, an urgent surgical approach should still be considered, whereas in patients with signs of pericarditis or pericardial effusion without the dramatic symptoms of esophageal fistula, an interventional therapeutic approach may be offered. Constant interdisciplinary communication and attention is needed to recognize and successfully manage potential evolving complications promptly, such as pneumopericardium, stent dislocation, and hematemesis.


Successful Nonsurgical Treatment of Esophagopericardial Fistulas After Atrial
Fibrillation Catheter Ablation: A Case Series
Charlotte Eitel, Sascha Rolf, Markus Zachäus, Silke John, Philipp Sommer, Andreas Bollmann,
Arash Arya, Christopher Piorkowski, Gerhard Hindricks and Ulrich Halm

Circ Arrhythm Electrophysiol. 2013;6:675-681; originally published online May 31, 2013;
doi: 10.1161/CIRCEP.113.000384
Circulation: Arrhythmia and Electrophysiology is published by the American Heart Association, 7272 Greenville
Avenue, Dallas, TX 75231
Copyright © 2013 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-3149. Online ISSN: 1941-3084

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://circep.ahajournals.org/content/6/4/675

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published
in Circulation: Arrhythmia and Electrophysiology can be obtained via RightsLink, a service of the Copyright
Clearance Center, not the Editorial Office. Once the online version of the published article for which
permission is being requested is located, click Request Permissions in the middle column of the Web page
under Services. Further information about this process is available in the Permissions and Rights Question and
Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Arrhythmia and Electrophysiology is online at:
http://circep.ahajournals.org//subscriptions/