Retrospective review of 65 atrioesophageal fistulas post atrial fibrillation ablation

Ameena Jehaludi, MD a, E. Kevin Heist, MD b, M. Russell Giveans, PhD a, Rishi Anand, MD a, *  

a Electrophysiology Department, Holy Cross Hospital, Fort Lauderdale, FL, USA  
b Electrophysiology Department, Massachusetts General Hospital, Boston, MA, USA

ARTICLE INFO

Article history:  
Received 19 January 2018  
Accepted 8 February 2018  
Available online 21 February 2018

ABSTRACT

Background: Although a rare complication of catheter based ablation for atrial fibrillation (AF), atrioesophageal fistula (AEF) is a serious and fatal event [1–5]. Most reports of AEF are single cases or small case series.  

Objective: The purpose of this study was to perform a comprehensive literature search of all published atrioesophageal fistula following catheter ablation for AF in order to identify the mortality rates associated with therapeutic modalities and suggest the most definitive management in reducing mortality.  

Methods: A comprehensive literature review of reported observational cases of atrioesophageal fistula post catheter based ablation for atrial fibrillation was performed.  

Results: Sixty-five cases of AEF post atrial fibrillation ablation were reviewed. The mean age was 55 years old. 73.8% (48/65) of the identified cases occurred in males (p < 0.001). Of the 65 cases, 13 underwent surgical radiofrequency ablation (RFA) and 52 underwent percutaneous RFA. Mortality resulted in 53.8% of those who underwent surgical RFA and in 55.8% of those who underwent percutaneous RFA (p = .888). The time range interval from procedure to onset of symptoms was 1–60 days. The most prevalent symptom, fever, occurred in 52 of the 65 cases, followed by neurological symptoms (n = 44). CT of the chest (n = 37), transthoracic echocardiogram (n = 21), and CT of the head (n = 18) were the preferred diagnostic modalities. Patients who underwent surgical correction with esophageal repair for treatment were more likely to survive, in comparison to patients who were treated with non-surgical interventions, such as antibiotic therapy, anticoagulation therapy or esophageal stenting. Of the total 34 patients who were treated surgically, 27 survived (79.4%). Of the total 31 patients who were treated non-surgically, only 2 survived (6.5%), reflecting significantly lower mortality with surgical versus non-surgical therapy (p < 0.001).  

Conclusion: Atrioesophageal fistula is an uncommon but potentially fatal complication of atrial fibrillation ablation. Patients who underwent surgical repair were twelve times more likely to survive than those treated with stenting, antibiotic therapy or no intervention. Based on the observation that patients are 12 times more likely to survive an AEF with surgery than without, the authors believe that prompt surgical correction of AEF should be considered as standard of care when dealing with this dreaded complication.

1. Introduction

Catheter based ablation is a common treatment option in patients who either failed or declined medical therapy for atrial fibrillation (AF). With the incidence and prevalence of atrial fibrillation increasing worldwide, the frequency of catheter based ablations also continues to rise. Ablation of AF most commonly involves creating circumferential lesions around the pulmonary vein ostia or antra with or without the placement of additional ablation lesions within the left atrium [3]. The left atrium is anterior to the esophagus [3,4]. The close proximity of the esophagus to the

https://doi.org/10.1016/j.ipej.2018.02.002
0972-6292/© 2018, Indian Heart Rhythm Society. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Table 1
Case reports included.

| Author                | # of Cases | Gender | Age (years) | Procedure                  | Clinical presentation                                                                 | Imagining Findings       | Diagnostic Procedure | Treatment | Outcome         |
|-----------------------|------------|--------|-------------|----------------------------|--------------------------------------------------------------------------------------|--------------------------|----------------------|-----------|-----------------|
| Pappone et al. [11]   | 1          | Male   | 59          | CPVA                       | Fever, weakness, rigor, grand mal seizures                                             | TTE/TEE                  | Autopsy              | Nonsurgical, Antibiotics | Death           |
| Mohanty et al. [8]    | 9          | Male   | 46          | RFCA                       | Fever, leukocytosis, stroke/TIA, Bilateral arm weakness                                 | Chest CT w/ contrast TTE | Chest CT w/ contrast | Esophageal Stent | Death           |
|                       |            |        |             | 8 – endocardial catheter based radiofrequency |                                                                      |                         |                      | IV antibiotics | Anticoagulation |
| Male                  | 61         | Male   | 28          | IRAAF                      | Fever, stroke/TIA, Heparesis, seizure                                                  | Chest CT w/ contrast TTE | Chest CT w/ contrast | Esophageal Stent | Death           |
|                       |            |        |             | 1 – hybrid epicardial left atrial ablation |                                                                      |                         |                      | IV antibiotics | Anticoagulation |
| Male                  | 45         | Male   | 35          | Temperature monitoring with esophageal probe | Fever, stroke TIA, leukocytosis, grand mal seizures, focal cortical signs              | Chest CT w/ contrast TTE | Chest CT w/ contrast | Esophageal Stent | Death           |
|                       |            |        |             |                            |                                                                      |                         |                      | IV antibiotics | Anticoagulation |
| Male                  | 58         | Male   | 28          | General anesthesia        | Stroke/TIA systemic embolism, chest pain, GI hemorrhage, leukocytosis, decreased reflexes, paresis | Chest CT w/ contrast TTE | Chest CT w/ contrast | Esophageal Stent | Death           |
|                       |            |        |             | 5 – conscious sedation |                                                                      |                         |                      | IV antibiotics | Anticoagulation |
| Female                | 62         | Female | 28          | CPVA                       | Fever, chest pain, sepsis, stroke/TIA, Leukocytosis, AMS, hemiparesis                  | Chest CT w/ contrast TTE | Chest CT w/ contrast | Surgery      | Survived        |
|                       |            |        |             |                            |                                                                      |                         |                      | IV antibiotics | Anticoagulation |
| Male                  | 51         | Male   | 14          | CPVA                       | Fever, rigor, chest pain, sepsis, GI bleed, stroke/ TIA, sudden blindness weak leg     | Chest CT w/ contrast TTE | Chest CT w/ contrast | Surgery      | Survived        |
|                       |            |        |             |                            |                                                                      |                         |                      | IV antibiotics | Anticoagulation |
| Male                  | 42         | Male   | 21          | CPVA                       | Fever, rigor, chest pain, sepsis, stroke/TIA, sudden blindness weak leg                | Chest CT w/ contrast TTE | Chest CT w/ contrast | Surgery      | Survived        |
|                       |            |        |             |                            |                                                                      |                         |                      | IV antibiotics | Anticoagulation |
| Male                  | 56         | Male   | 28          | CPVA                       | Fever, chest pain, dysphagia, confusion, leukocytosis, postprandial TIA, multiple petechiae, weak arm | Chest CT w/ contrast TTE | Chest CT w/ contrast | Surgery      | Survived        |
|                       |            |        |             |                            |                                                                      |                         |                      | IV antibiotics | Anticoagulation |
| Pappone et al. [9]    | 1          | Male   | 36          | Percutaneous: CPVA         | Fever, Pleuritic chest pain, sepsis, leukocytosis, CT of the head Bilateral ischemia | TTE                     | LA thrombus         | Thrombectomy, pericardial sutures | Death           |
| Pappone et al. [9]    | 1          | Male   | 21          | Percutaneous: CPVA         | Fever, Grand mal seizure Head CT Unremarkable Cerebral pneu-mocephalas                | TEE                     |                      | Surgical      | Survived        |
| Aryana et al. [11]    | 1          | Female | 55          | MAZE                       | Seizures, left hemiparesis, severe chest pain Head CT                               | Head CT                 |                      | Non-surgical  | Death           |
| Vassileva [12]        | 1          | Female | 72          | Percutaneous radiofrequency isolation of the pulmonary veins Surgical: LRFA – melo technique | Shortness of breath, nonproductive cough, palpitations, elevated WBC, seizure Fever, shivers, numbness right arm | TTE                     |                      | Surgery       | Survived        |
| Sonmez et al. [13]    | 1          | Female | 58          | LRFA                       | Fever, Pleuritic chest pain, sepsis, leukocytosis, CT of the head Bilateral ischemia | TTE                     |                      | Thrombectomy, pericardial sutures | Death           |
| Doll et al. [14]      | 1          | Male   | 42          | Surgical: IRAAF            | Fever, postprandial TIA TTE Normal Exploratory thoracotomy Pathology                  | TEE                     |                      | Surgical      | Survived        |
| Doll et al. [14]      | 1          | Female | 62          | Surgical: IRAAF            | Hematemiesis, EGD NA                                                                 | TEE                     |                      | None         | Death           |
| Doll et al. [14]      | 1          | Male   | 59          | Surgical: IRAAF            | Fever, neurological symptoms CT of the chest NA Esophageal perforation EGD             | TEE                     |                      | Exploratory  | Survived        |
| Doll et al. [14]      | 1          | Male   | 36          | Surgical: IRAAF            | Chest pain CT of the chest NA Exploratory thoracotomy                                | TEE                     |                      | Surgical      | Survived        |
| Scanavacca et al. [15]| 1          | Male   | 72          | Percutaneous: RFA          | Seizures, Hematemiesis Multiple intracerebral air emboli and infarction EGD            | TEE                     |                      | Non-surgical  | Death           |
| Zirlik and Nordt [16] | 1          | Male   | 66          | Surgical: MVR and MAZE procedure | Collapse CT of the head Multiple intracerebral air emboli and infarction EGD         | TEE                     |                      | Non-surgical  | Survived        |
| Bunch et al. [17]     | 1          | Male   | 48          | Percutaneous: RFA          | Fever, chest pain, dysphagia CT of the chest EGD                                      | TEE                     |                      | Survived      |                |

(continued on next page)
| Author            | # of Cases | Gender | Age (years) | Procedure                                      | Post procedure Day | Clinical presentation                                                                 | Imaging          | Findings                                      | Diagnostic Procedure | Treatment | Outcome |
|-------------------|------------|--------|-------------|-----------------------------------------------|--------------------|----------------------------------------------------------------------------------------|------------------|----------------------------------------------|----------------------|-----------|---------|
| Schley et al.     | 1          | Male   | 37          | Percutaneous: RFA                            |                    | Fever, Grand mal seizure, status epilepticus, Sepsis (9), neurological symptoms (8), angina (2), GI bleed (3), occult bleed (5) | CT of the head   | CT of chest                                   | Surgical             | Survived  |         |
| Cummings et al.   | 9          | Male – 4 Female – 5 | | Percutaneous: RFA                            |                    | Fever (3) chest pain (2), hemiparesis (3), grand mal seizure (1), aphasia (1) | No vegetations   | CT of chest (3/4); autopsy(6/9)       | Surgical             | Death – 9 |         |
| Dages et al.      | 5          | Male – 4 Female – 1 | | Surgical: RFA (n – 4); Percutaneous: RFA (n – 1) |                    | Fever, altered mental status, petechiae fever, atypical atrial flutter, VF arrest | CT of the head   | CT of chest                                   | Surgery – 3          | Survived  |         |
| Malamis et al.    | 1          | Male   | 59          | Percutaneous: RFA                            |                    | Epigastric pain, dysphagia, tactile fever, focal weakness, anosmia, acalculia, agraphia | MRI of the brain | Multiple subacute embolic events            | Surgical             | Survived  |         |
| D’Avila et al.    | 1          | Male   | 56          | Percutaneous: RFA                            |                    | Chest discomfort and atypical atrial flutter, VF arrest | MRI of the brain | Cerebral and cerebellar ischemic lesions   | Surgical             | Death     |         |
| Hazel et al.      | 1          | Male   | 72          | Percutaneous: PVI with RFA                   |                    | 16 Weakness, loss of consciousness, chest pain | CT of the head   | Right parietal subcortical motor ischemic changes | CT of chest         | Nonsurgical | Death   |
| Vijayaraman et al.| 1          | Male   | 45          | Percutaneous: RFA                            |                    | Chest pain, low grade fever, hypotension | CT of the chest | Fluid and air in pericardium and air in right superior mediastinum | Thoracotomy          | Surgical   | Survived |
| Baker et al.      | 1          | Female | 67          | Surgical: RFA                                |                    | Subternal chest pain, nausea, vomiting, confusion, fever, seizures, hematemesis | MRI of the brain | Multiple acute emboli                         | EGD                  | Nonsurgical | Death   |
| Cazavet et al.    | 1          | Male   | 35          | Percutaneous: RFA                            |                    | 38 Fever, chest pain, vomiting, left hemiplegia and seizures | CT of the head   | Initially negative                           | CT of chest          | Surgical   | Survived |
| Gilcrease et al.  | 1          | Male   | 61          | Percutaneous: RFA                            |                    | Dysphagia, subternal chest pain, fever | CT of the chest | Ulcer at anterior portion esophagus adjacent to PV Normal | CT of chest (after 2 months) | Surgical   | Death    |
| Khandhar et al.   | 1          | Male   | 46          | Percutaneous: RFA                            |                    | 27 Fever, pericarditis, followed by hemiparesis | CT of the chest | Multifactorial infarcts                     | CT of chest          | Survived   |         |
| Siegel et al.     | 1          | Male   | 41          | Percutaneous: RFA                            |                    | Fever, rigors near syncope; followed by right sided hemiparesis | MRI of the brain | Pneumocardiopexy                             | EGD                  | Surgical   | Survived |
| Grubina et al.    | 1          | Male   | 72          | Percutaneous: RFA                            |                    | 9 Pleuritic chest pain | CT of the chest PAD # 15 TTE | No vegetations | CT of chest Survival  | Surgical             | Survived   |         |
| St Julien et al.  | 1          | Male   | 59          | Percutaneous: transeptal LA ablation with ThermoCool catheter |                    | 42 Chest pain, diaphoresis, headache, fever, altered mental status | CT of the head   | Several large intracerebral lesions suspicious for air embolism | CT of chest         | Nonsurgical | Death    |
| Zellerhoff et al. | 1          | Male   | 63          | Percutaneous: RFA with 3D mapping            |                    | 14 Muscle weakness, generalized fatigue followed by fever and left sided hemiparesis | CT of the head   | Unable to localize source of bleeding        | EGD                  | Nonsurgical | Death    |
| Purgerfellner et al.| 1          | Male   | 49          | Percutaneous: RFA                            |                    | 29 Fever, chills, nausea, emesis, altered mental status, atherothrombotic movements, skin changes, hematemesis | EGD | Negative                                   | Cardiac CT           | Nonsurgical | Survived |
| Stockigt et al.   | 1          | Male   | 78          | Percutaneous: cryoballoon PV isolation       |                    | 28 Fever, shivers, cough for 10 days, followed by neurological symptoms | CT of the chest and abdomen |                   | CT of chest Survival  | Surgical             | Survived   |         |
left atrium makes it susceptible to potential injury during catheter based ablation of AF [7].

While the possible complication of atrioesophageal fistula is rare post catheter ablation of AF, it is, none-the-less a severe, life-threatening complication that is one of the most feared [1,3,6]. It is estimated to occur in 1 of 500—1000 cases [6]. The mortality rate associated with AEF has been reported to surpass 60%—80% [5,10].

We have reviewed the clinical characteristics, discuss diagnostic modalities and determine the most definitive treatment options available, in order to recognize and promptly treat AEF, given its fatal outcome [1].

2. Methods

2.1. Search strategy

The purpose of this study was to collate cases of AEF post ablation for AF that were identified from published reports in the literature. PubMed is a searchable online database and service of the US National Library of Medicine that provides access to medical journal articles. A systemic search of the database PubMed from inception to June 2017 was performed. The search terms included "atrioesophageal fistula" or "atrio-esophageal fistula" or "esophagogastric fistula" or "esophago-atrial fistula." These terms were searched as free text in the title or the abstract [1]. In addition, Google Scholar, another searchable online database, was systematically searched with the same terms as above. Lastly, we reviewed reference lists of bibliographies of the listed articles.

2.2. Selection criteria

Case reports selected reported: (1) the primary diagnosis as AF for ablation procedure; (2) clinical presentation; (3) diagnostic imaging; (4) management and (5) outcome [1].

2.3. Statistical analysis

For this systematic review of case reports, we used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement protocol. Chi-squared analyses were used to determine differences in percentages between groups. Statistical significance was set at 0.05 [1].

3. Results

3.1. Demographics and clinical presentation

Sixty-five cases of AEF post atrial fibrillation ablation were reviewed and compiled into a table (Table 1). The mean age was 55 years old. 73.8% (48/65) of the identified cases occurred in males and 26.2% (17/65) occurred in females (p < 0.001) (Fig. 1). Of the 65 cases, 13 (20%) underwent surgical RFA and 52 (80%) underwent percutaneous RFA. Mortality resulted in 53.8% of those who underwent surgical RFA and in 55.8% of those who underwent percutaneous RFA (p < 0.888) (Fig. 2). Given these results, there is no clinical significance in mortality between those who underwent surgical versus percutaneous radiofrequency ablation. The range
Fig. 1. The total number of males compared to females found to have atrioesophageal fistula post atrial fibrillation ablation. 73.8% (48/65) of the identified cases occurred in males and 26.2% (17/65) occurred in females ($p < 0.001$).

Fig. 2. Comparison of the number of patients with AEF who initially underwent surgical radiofrequency (RFA) versus percutaneous RFA for treatment of atrial fibrillation. Of the 65 cases, 13 (20%) underwent surgical RFA and 52 (80%) underwent percutaneous RFA. Mortality resulted in 53.8% (7/13) of those who underwent surgical RFA and in 55.8% (29/52) of those who underwent percutaneous RFA ($p < 0.888$). Thus, there is no difference in mortality between patients who underwent surgical RFA versus percutaneous RFA.

Fig. 3. The frequency of symptoms in patients with AEF post atrial fibrillation at the initial time of presentation. Symptoms will likely occur in a triad of fever, neurological deficits (such as hemiparesis) and/or hematemesis, all three of which make up the most frequent clinical presentations identified.
Interval from procedure to onset of symptoms was 1–60 days (Table 1) [1,3]. Fever occurred most commonly in 52 of the 65 cases, followed by neurological symptoms such as hemiparesis, stroke/TIA, motor and language impairment which occurred in 44 cases. Patients also presented with hematemesis (n = 21), chest pain (n = 19), altered mental status (n = 18), seizures (n = 12), dysphagia (n = 6), loss of consciousness (n = 5), nausea/vomiting (n = 5), abdominal pain (n = 3), cough (n = 3), dyspnea (n = 2), headache (n = 2), melena (n = 1), and odynophagia (n = 1) (Fig. 3).

3.2. Diagnostic modalities, treatment and outcome

Among the diagnostic modalities employed were CT of the chest (n = 37), transthoracic echocardiogram (n = 21), and CT of the head (n = 18) (Fig. 4). Air embolism was most commonly identified in 17 patients, followed by pneumomediastinum identified in 12 patients (Table 1).

Of the total 65 cases reviewed, 36 resulted in deaths, whether surgically or non-surgically treated. Thus, the total mortality rate of all cases reviewed was 55.4%, making atrioesophageal fistula a rare, but grave outcome post atrial fibrillation ablation.

Patients who underwent surgical correction with esophageal repair for treatment were more likely to survive, in comparison to patients who were treated with non-surgical interventions, such as antibiotic therapy, anticoagulation therapy or esophageal stenting. Mortality rates were significantly reduced in those who underwent surgical intervention at 20.6% (7/34) versus a mortality rate of 93.5% (29/31) in patients who were not treated surgically (p < 0.001) (Fig. 5).

4. Discussion

Atrioesophageal fistula, an uncommon but adverse event of atrial fibrillation catheter based ablation, is associated with a high fatality rate. The mortality rate associated with surgical RFA was 53.8% (7 deaths in a total of 13 patients who underwent surgical
RFA) versus 55.8% with percutaneous RFA (29 deaths in a total of 52 patients who underwent percutaneous RFA) (p < 0.001). Thus, there is no difference in mortality between surgical RFA and percutaneous RFA.

Patients may present with non-specific symptoms, ranging from 1 to 60 days after the ablation (Fig. 6) [1,3]. Common symptoms may include a triad of fever, neurological deficits (such as hemiparesis) and/or hematemesis [1]. Other symptoms may include chest discomfort, altered mental status, seizures, abdominal pain, nausea, vomiting, dysphagia, odynophagia, melena, and dyspnea (Fig. 3). Given the high mortality rate, it is essential to hold a high index of clinical suspicion in patients who recently underwent ablation for AF and present with such non-specific symptoms [1,3,7].

The most common diagnostic modality for identifying AEF following AF ablation includes CT of the chest, TTE and CT of the head. Other methods of imaging used included esophogram, MRI of the brain, TEE, CT of the abdomen or pelvis, and Cardiac CTA (Fig. 4). Concern has been raised regarding the performance of esophagoscopy in the setting of potential AEF, in which air insufflation into the esophagus could push air or esophageal contents into the left atrium.

The total mortality rate of cases reviewed, with surgical and nonsurgical interventions, was 55.4% (36 total deaths out of 65 total cases). 79.4% of patients with AEF post AF ablation survived after undergoing surgical correction with esophageal repair, compared to 6.5% of patients who were treated with non-surgical interventions. Overall, patients who underwent surgical repair were twelve times more likely to survive than those treated with stenting, antibiotic therapy or no intervention at all [5]. With such a large survival advantage conferred by definitive surgical intervention, we advocate that definitive and prompt surgical intervention should be the standard of care for such a dreaded complication (Fig. 5).

5. Limitations

This is a retrospective review of published cases of AEF, and it is likely that many cases of AEF have not been published and so not available to include in this review. It is not possible from these data to assess or compare the incidence of AEF with catheter or surgical ablation. Additionally, there may be important differences between patients who underwent surgical versus non-surgical treatment for AEF which might have impacted the mortality rates of these cases.

6. Conclusions

Atrioesophageal fistula is an uncommon but adverse event of atrial fibrillation catheter based ablation associated with increased fatality. Patients who underwent surgical repair were twelve times more likely to survive than those treated with stenting, antibiotic therapy or no intervention. Based on the observation that patients are 12 times more likely to survive an AEF with surgery than without, the authors believe that prompt surgical correction of AEF should be considered as standard of care when dealing with this dreaded complication.

References

[1] Chavez P, Messerli FH, Casso Dominguez A, Aziz EF, Sichrovsky T, Garcia D, Barrett CD, Danik S. Atrioesophageal fistula following ablation procedures for atrial fibrillation: systematic review of case reports. Open Heart 2015;2:1–8.
[2] John RM, Kapur S, Ellenbogen KA, Koneru JN. Atrioesophageal fistula formation with cryoballoon ablation is most commonly related to the left inferior pulmonary vein. Heart Rhythm 2017;14:2:184–9.
[3] Nair KKM, et al. Atrioesophageal fistula: a review. J Atr Fibrillation 2015;8:3:1331.
[4] Pappone C, Vicedomini G, Santinelli V. Atrio-esophageal fistula after AF ablation: pathophysiology, prevention & treatment. J Atr Fibrillation 2013;6:2:860.
[5] Black-Maier E, Pokorney SD, Barnett AS, Emily PZ, Sun AV, Jackson KP, Bahnsen TD, Daubert JP, Piccini JP. Risk of atrioesophageal fistula formation with contact force sensing catheters. Heart Rhythm 2017;14(9):1328–33.
[6] John RM, Kapur S, Ellenbogen KA, Koneru JN. Atrioesophageal fistula formation with cryoballoon ablation is most commonly related to the left inferior pulmonary vein. Heart Rhythm 2017;14:2:184–9.
[7] Garg L, Garg J, Gupta N, Shah N, Krishnamoorthy P, Palaniswamy C, Bozorgnia B, Natale A. Gastrointestinal complications associated with catheter ablation for atrial fibrillation. Int J Cardiol 2016;224:424–35.
[8] Mohanty S, et al. Outcomes of atrioesophageal fistula following catheter ablation of atrial fibrillation treated with surgical repair versus esophageal stenting. J Cardiovasc Electrophysiol Oct. 2014;25(6):579–84.
[9] Pappone C, Oral H, Santinelli V, Vicedomini G, Lang GC, Manguio F, Torracca L, Benussi S, Alferi O, Hong R, Lau W, Hirata K, Shikuma N, Hall B, Morady F. Atrio-esophageal fistula as a complication of percutaneous transcatheter ablation of atrial fibrillation. Circulation 2004;109:22:2724–6.
[10] Ghia KK, Chugh A, Good E, Frank Pelosi KJ, Bogun F, Morady F, Oral H. A nationwide survey on the prevalence of atrioesophageal fistula after left atrial radiofrequency catheter ablation. J Intervent Card Electrophysiol 2008;24:1:33–6.
[11] Aryana A, et al. Catastrophic manifestations of air embolism in a patient with atrioesophageal fistula following minimally invasive surgical ablation of atrial fibrillation. J Cardiovasc Electrophysiol 2013;24(8):933–4.
[12] Vassileva CM, et al. Repair of left atrial-esophageal fistula following
percutaneous radiofrequency ablation for atrial fibrillation. J Card Surg 2011;26(5):556–8.

[13] Sommez B, Demirsoy E, Yagci N, et al. A fatal complication due to radiofrequency ablation for atrial fibrillation: atrio-esophageal fistula. Ann Thorac Surg 2003;76:281–3.

[14] Doll N, Borger MA, Fabricius A, et al. Esophageal perforation during left atrial radiofrequency ablation: is the risk too high? J Thorac Cardiovasc Surg 2003;125:836–42.

[15] Scanavacca MI, D’Avila A, Parga J, et al. Left atrial-esophageal fistula following radiofrequency catheter ablation of atrial fibrillation. J Cardiovasc Electrophysiol 2004;15:960–2.

[16] Zurlink A, Nordt TK. Massive air embolism after Maze. Heart 2005;91:736.

[17] Bunch TJ, Nelson J, Foley T, et al. Temporary esophageal stenting allows healing of esophageal perforations following atrial fibrillation ablation procedures. J Cardiovasc Electrophysiol 2006;17:435–9.

[18] Schley P, Gulker H, Horlitz M. Atrio-oesophageal fistula following circumferential pulmonary vein ablation: verification of diagnosis with multislice computed tomography. Europace 2008;8:189–90.

[19] Cummings JE, Schwenkert RA, Saliba WL, et al. Brief communication: atrial-esophageal fistulas after radiofrequency ablation. Ann Intern Med 2006;144:572–4.

[20] Dagens N, Kottkamp H, Piorowski C, et al. Rapid detection and successful treatment of esophageal perforation after radiofrequency ablation of atrial fibrillation: lessons from five cases. J Cardiovasc Electrophysiol 2006;17:1213–5.

[21] Preis O, Digumarthy SR, Wright CD, et al. Atrioesophageal fistula after catheter ablation of atrial fibrillation: imaging features. J Thorac Imaging 2007;22:283–5.

[22] Malamis AP, Kirshenbaum KJ, Nadimpalli S. CT radiographic findings: atrioesophageal fistula after transcatheter percutaneous ablation of atrial fibrillation. J Thorac Imaging 2007;22:188–91.

[23] A’Vila A, Ptaszek LM, Yu PB, et al. Images in cardiovascular medicine. Left atrial-esophageal fistula after pulmonary vein isolation: a cautionary tale. Circulation 2007;115:e432–3.

[24] Borchert B, Lawrenz T, Hansky B, et al. Lethal atrioesophageal fistula after pulmonary vein isolation using high-intensity focused ultrasound (HIFU). Heart Rhythm 2008;5:145–8.

[25] Ouchikhe A, Maindivide J, Le Bivic JL, et al. Atrio-oesophageal fistula after radiofrequency ablation: predominant neurological symptoms. Ann Fr Anesth Reanim 2008;27:499–501.

[26] Hazell W, Heaven D, Kazemi A, et al. Atrio-oesophageal fistula: an emergent complication of radiofrequency ablation. Emerg Med Australas 2009;21:329–32.

[27] Vijayaraman P, Netrebko P, Geyfman V, et al. Esophageal fistula formation despite esophageal monitoring and low-power radiofrequency catheter ablation for atrial fibrillation. Circ Arrhythm Electrophysiol 2009;2:e31–3.

[28] Baker MJ, Panchal PC, Allenby PA. Life-threatening GI hemorrhage caused by atrioesophageal fistula: a rare complication after catheter ablation for atrial fibrillation. Gastrointest Endosc 2010;72:887–9.

[29] Cazavet A, Muscari F, Marachet MA, et al. Successful surgery for atrioesophageal fistula caused by transcatheter ablation of atrial fibrillation. J Thorac Cardiovasc Surg 2010;140:e43–5.

[30] Gilcrease GW, Stein JB. A delayed case of fatal atrioesophageal fistula following radiofrequency ablation for atrial fibrillation. J Cardiovasc Electrophysiol 2010;21:708–11.

[31] Khandhar S, Nitzschke S, Ad N. Left atrioesophageal fistula following catheter ablation for atrial fibrillation: off-bypass, primary repair using an extrapericardial approach. J Thorac Cardiovasc Surg 2010;139:507–9.

[32] Siegel MO, Parenti DM, Simon GL. Atrial-esophageal fistula after atrial radiofrequency catheter ablation. Clin Infect Dis 2010;51:713–6.

[33] Grubina R, Cha YM, Bell MR, et al. Pneumopericardium following radiofrequency ablation for atrial fibrillation: insights into the natural history of atrial esophageal fistula formation. J Cardiovasc Electrophysiol 2010;21:1046–9.

[34] St Julien J, Putnam Jr JB, Nesbitt JC, et al. Successful treatment of atrioesophageal fistula by cervical esophageal ligation and decompression. Ann Thorac Surg 2011;91:e85–6.

[35] Zellerhoff S, Lenze F, Schulz R, et al. Fatal course of esophageal stenting of an atrioesophageal fistula after atrial fibrillation ablation. Heart Rhythm 2011;8:624–6.

[36] Puruerfellner H, Stollberger C, Finsterer J. Meningo-encephalitis as initial manifestation of a fatal atrio-esophageal fistula after atrial fibrillation ablation. Acta Cardiol 2011;66:555–7.

[37] Stockigt F, Schrickel JW, Andrie R, et al. Atrioesophageal fistula after cryoballoon pulmonary vein isolation. J Cardiovasc Electrophysiol 2012;23:1254–7.

[38] Tanscveski I, Hintringer F, Stuehlinger M, et al. Atrioesophageal fistula after percutaneous transcatheter ablation of atrial fibrillation. Circulation 2012;125:966–.

[39] Haggery KA, George TJ, Arnaoutakis GJ, et al. Successful repair of an atrioesophageal fistula after catheter ablation for atrial fibrillation. Ann Thorac Surg 2012;93:313–5.

[40] Kanth P, Fang J. Cerebral air embolism: a complication of a bleeding atrioesophageal fistula. Clin Gastroenterol Hepatol 2012;10:A22.

[41] Ben-David K, Rosenthal M, Chauhan SS. A novel strategy for the management of acute hemorrhage from an atrio-esophageal fistula after atrial ablation. Am Surg 2012;78:E286–7.

[42] Hartman AR, Glassman I, Katz S, et al. Surgical repair of a left atrial-esophageal fistula after radiofrequency catheter ablation for atrial fibrillation. Ann Thorac Surg 2012;94:e91–3.

[43] Zini A, Carpeggiani P, Pinelli G, et al. Brain air embolism secondary to atrial-esophageal fistula. Arch Neurol 2012;69:785.

[44] Rivera GA, David IB, Andand RC. Successful atrioesophageal fistula repair after atrial fibrillation ablation. J Ann Cardiol 2013;61:1204.

[45] Tan C, Coffey A. Atrioesophageal fistula after surgical unipolar radiofrequency atrial ablation for atrial fibrillation. Ann Thorac Surg 2013;95:e61–2.

[46] Shim HB, Kim C, Kim HK, et al. Successful management of atrio-esophageal fistula after cardiac radiofrequency catheter ablation. Korean J Thorac Cardiovasc Surg 2013;46:142–5.

[47] Neven K, Schmidt B, Metzner A, et al. Fatal end of a safety algorithm for pulmonary vein isolation with use of high-intensity focused ultrasound. Circ Arrhythm Electrophysiol 2010;3:260–5.

[48] Duas S, Gerstenfeld EP, Ratcliffe SJ, et al. Single procedure efficacy of isolating all versus arrhythmogenic pulmonary veins on long-term control of atrial fibrillation: a prospective randomized study. Heart Rhythm 2008;5:174–81.