Catheter ablation is a treatment modality which has been used increasingly for cardiac arrhythmias. However, it is not complication-free. Among the catheter-related complications, cardiac perforation is one of the most life-threatening situations. Treatment options include conservative treatment, pericardiocentesis, surgical repair, and combination therapy, but it is still challenging to make a best decision to choose the treatment option for every episode. For hemodynamic unstable patients, pericardiocentesis will usually be done at first if prominent pericardial effusion is found after catheter ablation or electrophysiology study (EPS), by which the majority of the patients could be stabilized. Surgical treatment will be considered only if hemodynamics is still unstable or if there is rapid re-accumulation of pericardial effusion despite pericardiocentesis. Because surgical repair is usually not the first-line treatment of choice for cardiac perforation following catheter ablation or EPS, limited case numbers underwent surgical repair, and many surgeons have no sufficient experiences for managing this kind of catastrophic situations. Thus, the options of surgical strategies for cardiac perforation following catheter ablation were only sporadically reported, and there were no large case series published in the literature. This systemic review primarily aims to collect various life-saving surgical strategies used for patients with cardiac perforation following catheter ablation or EPS who could not be stabilized by pericardiocentesis and concomitant medical management to help cardiovascular surgeons deal with such a life-threatening situation confidently and to help more patients recover from the critical condition.

Methods

This systemic review was conducted in accordance with the Guidelines for Systematic Reviews and Meta-Analyses. We performed a systemic literature search in PubMed and MEDLINE. There was no similar review article found in the Cochrane library. Keywords used for searching included “electrophysiology,” “electrophysiological study,” “arrhythmia,” “catheter ablation,” “cardiac rupture,” and “cardiac perforation.” The search was limited to the English language and to human studies but not limited to the publication time. In addition to the articles...
searched by keywords, the reference lists of all the relevant articles were also checked carefully. Two investigators independently reviewed the titles and abstracts of the searched articles which were included in this study if the following criteria were met: (1) EPS performed for arrhythmias, (2) catheter ablation as the treatment modality for arrhythmias, (3) occurrence of pericardial effusion following catheter ablation or EPS, and (4) documentation of surgical strategies or procedures for catheter-related cardiac perforation. Those articles deemed relevant were selected for further consideration (Figure 1). Thereafter, data extraction of included studies was completed by two independent reviewers. Only surgical cases in the searched studies were analyzed. Other ablation-related complications such as aortic rupture, coronary artery injury, and valve injury were not enrolled in this study, which was focused on the surgical treatment for cardiac perforation following catheter ablation or EPS. Articles without any descriptions of clinical course or surgical procedures for cardiac perforation were also excluded from this study. The extracted data included the name of author, year of publication, age and gender of patients, type of arrhythmias, ablation procedure, onset of catheter-related complications, hemodynamics during cardiac perforation, perforation sites of the heart, preoperative pericardiocentesis or not, preoperative cardiopulmonary resuscitation (CPR) or not, interval between cardiac perforation and surgical treatment, surgical procedures, outcomes, and interval between cardiac perforation and death. The extracted data were compiled into tables. Continuous variables were presented as mean ± standard deviations. Categorical variables were expressed as numbers and percentages.

Results

By our searching strategy, 452 studies were retrieved from the databases. After screening, 22 articles were included in this study (Figure 1). Because surgical repair was only preferred if pericardiocentesis and concomitant medical management failed to stabilize the patients with cardiac perforation following catheter ablation or EPS, the case numbers of the patients undergoing surgical repair were limited, and there were only sporadic surgical reports published in the literature.

Among the 22 articles searched from the databases, there were totally 38 patients who underwent surgical repair for cardiac perforation following catheter ablation or EPS alone (Table 1), and the publication year was from 1998 to 2020. The median age at presentation was 67 years (mean 62.9 ± 15.6 years, range 23-87 years), and 59% of the patients were male. Among the 22 searched articles, there were 32 patients experiencing cardiac perforation following catheter ablation by radiofrequency, 5 patients suffering from cardiac perforation following EPS without ablation, and 1 patient whose cardiac perforation happened when wiring for ablation. Regarding the types of the arrhythmias, there were atrial fibrillation (AFib) in 11 patients, ventricular tachycardia (VT) in 11 patients,
Wolf-Parkinson-White (WPW) syndrome in 4 patients, frequent premature ventricular complex in 2 patients, atrial flutter (AFL) in 1 patient, and atrial ectopic tachycardia (AET) in 1 patient. The type of arrhythmia was not described in one article (eight patients). For the patients (n = 13) with atrial arrhythmia (AFib, AFL, AET), there were 6 patients treated with pulmonary vein isolation (PVI), 4 patients treated with LA ablation, 2 patients treated with unknown procedures, and 1 patient who experienced cardiac perforation before ablation. Regarding the timing of cardiac perforation occurrence, 84% (32/38) of the patients were found to have pericardial effusion acutely following catheter-related procedures, and 16% (6/38) of the patients experienced delayed onset. For the patients (n = 32) who suffered from cardiac perforation soon after ablation or EPS and were hemodynamically unstable despite pericardiocentesis, there were 23 patients who were sent to operating room (OR) immediately from catheterization laboratory (CL), 5 patients undergoing surgical repair within 48 hours, and 1 patient each receiving surgery after catheter-related procedures which was performed 36 hours ago, after transferred from CL through ICU to OR, after transferred from CL through ward to OR, and after transferred from CL to OR of other hospital (Table I). Among the patients with delayed onset of cardiac perforation (n = 6), the median duration between

| Author                  | Age/ Sex | Procedure | Rhythm | Onset   | ICPS | PC  | BA | CC by PC |
|-------------------------|----------|-----------|--------|---------|------|-----|----|---------|
| Tsang (1998)            | 75/M     | E         | NA     | Acute   | < 48 hours | Y   | NA | No      |
| Hsu (2003)              | 67/M     | A (PVI)   | PAF    | Acute   | CL to OR | Y   | 850 cc | No      |
| Kono (2005)             | 61/F     | A         | WPW    | Acute   | 36 hours | N   | --  | --      |
| Bunch (2005)           | 48/M     | A (PVI)   | AFL    | Acute   | CL to OR | Y   | 2500 cc | No      |
| Bahcivan (2009)         | 42/F     | Ax        | AFib   | Acute   | CL to OR | Y   | 150 cc | No      |
| Jimenez (2011)          | 69/M     | A         | VT     | Acute   | CL to OR | Y   | 1200 cc | No      |
| Tokuda (2011)           | 49/F     | A         | VT     | Acute   | CL to OR | Y   | 100 cc  | NA      |
| Huang (2011)            | NA       | A         | RVOT   | Acute   | CL to OR | Y   | 1400 cc | No      |
| Nagamine (2011)         | 69/M     | A         | WPW    | Acute   | CL to OR | Y   | 600 cc | No      |
| Vergara (2011)          | 74/M     | A (NA)    | AFib   | Acute   | CL to OR | Y   | NA  | No      |
| Liu (2012)              | 64/M     | A (PVI)   | PAF    | Acute   | CL to OR | Y   | 800 cc | No      |
| Fiore (2014)            | 84/M     | A         | VT     | Acute   | CL to ICU to OR | N | --  | --      |
| Hirata (2015)           | 70/F     | A         | WPW    | Acute   | CL to OR | Y   | NA  | N      |
| Oz (2016)               | 45/M     | A         | VT     | Acute   | CL to OR | Y   | 100 cc | No      |
| Cao (2016)              | 61/M     | A         | Frequent PVC | Acute   | CL to ward to OR | Y   | 750 cc | No      |
| Mujovic (2016)          | 64/M     | A (PVI)   | PAF    | Acute   | CL to OR | Y   | NA  | No      |
| Yetter (2017)           | 57/M     | A (NA)    | AFib   | Delayed | 61 days | Y   | 400 cc | No      |
| Schuring (2017)         | 72/M     | A (LA)    | AFib   | Delayed | > 27 days | N | --  | --      |
| Velghe (2017)           | 32/F     | A (PVI)   | AET    | Delayed | 66 days | N  | --  | --      |
| Gennari (2019)          | 64/M     | E         | VT     | Acute   | CL to OR | Y   | 300 cc | No      |
| Siliato-Robles (2019)   | 23/M     | A         | WPW    | Delayed | > 2 months | N | --  | --      |
| Shenthar (2020)         | 70/M     | A         | VT     | Acute   | CL to OR | Y   | NA  | No      |

A indicates ablation; AET, atrial ectopic tachycardia; AFL, atrial flutter; AFib, atrial fibrillation; E, electrophysiology study; CC, complication; PC, pericardiocentesis; BA, blood aspirated; ICV, intercostal vessels; WPW, Wolf–Parkinson–White syndrome; PAF, paroxysmal atrial fibrillation; PVC, premature ventricular complex; RV, right ventricle; RVOT, right ventricular outflow tract; VT, ventricular tachycardia; NA, not available; ICPS, interval between cardiac perforation and surgery; CL, catheterization laboratory; OR, operating room; and ICU, intensive care unit.
catheter ablation and cardiac tamponade was 28.5 days (mean 37.6 ± 17.9 years, range 21-61 years). However, the longest duration between catheter ablation and cardiac perforation was 9 months disclosed by autopsy in one searched article, in which the patient suddenly collapsed at the workplace and the resuscitative attempts were unsuccessful. In the acute-onset group, 93.7% of the patients (30/32) underwent pericardiocentesis at first. In the delayed-onset group, 33.3% of the patients (2/6) received pericardiocentesis. For the patient receiving pericardiocentesis (n = 32), the mean drainage amounts for 19 patients were 983 +/- 899 cc (median 750 cc, range 100-3000 cc), and there was no documentation of drainage amounts for 13 patients. When it comes to preoperative hemodynamics, all the patients in the acute-onset group (n = 32) experienced hypotension, tamponade, collapse, or electric mechanical dissociation (EMD), whereas in the delayed-onset group (n = 6), 4 patients had hypotension or cardiac arrest, but 2 patients had unusual presentations (1 sepsis, 1 right hemiplegia) which were not related to bleeding. Seven patients in the acute-onset group and one patient in the delayed-onset group were undergoing CPR preoperatively.

Regarding the surgical procedures, four patients underwent removal of clots only, eight patients underwent suture repair of the LV, nine patients underwent sutureless repair of the RV, five patients underwent suture repair of the LA, and four patients underwent sutureless repair of the LV, RV, and PV (LV 1, RV 1, PV 1). In addition to repair of perforation sites, the concomitant combined procedures included repair of intercostal vessels (complication of pericardiocentesis) for one patient, cryoablation for two patients, and maze procedure for one patient. Intra-aortic balloon pump (IABP) was used postoperatively for three patients: (1) RV repair in whom biventricular assist device (BVAD) was implanted due to heart failure for one patient who ended up with heart transplantation and survived to discharge, (2) suture repair of the RV combined with cryoablation under CPB for another patient who survived to discharge, and (3) sutureless repair of the LV for the third patient in whom gauze packing was done to assist hemostasis after glue was applied to the perforation site of the LV which was too fragile to be repaired by suture attempt. For one patient with LV repair, left ventricular assist device (LVAD) was implanted due to heart failure, aortic valve replacement (AVR) was performed concomitantly with LVAD implantation, and the patient survived to discharge.

When it comes to sutureless repair, glue application +/- patch repair was used for closure of perforation site for four patients. (1) suture repair of the LV combined with glue application was performed in one patient; (2) in one patient with RV perforation using glue for sutureless repair, perforation hole was located at RV free wall but close to left anterior descending coronary artery, which would be injured if suture repair was done; (3) in one patient with LV perforation, suture repair was done under CPB and concomitant glue application over the suture site, which was covered with a piece of pericardial patch fixed by suture in the end; and (4) in one patient with perforation of LV inferior wall, glue was applied to the perforation site instead of suture repair due to fragile myocardium, which was covered with Hemopatch by interrupted suture.

All the patients except four survived the life-threatening episode. For one patient who died within 30 days after cardiac perforation following catheter ablation, there was no bleeding problem after surgery, and the cause of mortality was thought to be primarily related to the underlying cardiac disease. For one patient with LV perforation and LA dissection after ablation, although the LV was repaired and there was much improvement of LA dissection after suture repair, the postoperative recurrence of LA dissection resulted in significant impairment of LV filling, and the patient died in the hospital 9 days after ablation as the re-repair of LA dissection was not done due to the precarious general condition of the patient. For one patient who was readmitted for LA esophageal fistula 27 days after ablation, massive bleeding occurred during surgical repair, and the patient died at the OR. For one patient who was readmitted 21 days after ablation for delayed onset of cardiac tamponade, pericardiocentesis was performed, but RV injury was complicated, and then removal of blood and clots in the pericardial cavity was done, and no bleeder except the RV was found during surgery. However, 7 days later, the patient died of sepsis and central failure resulting from bilateral multiple acute cerebral infarction possibly caused by fistula between the right pulmonary vein and esophagus which was not found during surgery but was confirmed by autopsy.

Table II presents the preoperative condition, the surgical procedures, and the outcomes for all the patients.

### Discussion

Catheter ablation has been used increasingly to treat various kinds of cardiac arrhythmias. However, this procedure is not complication-free and it was reported in large-scale surveys that 2.9%-6.0% of patients suffered from major complications, including in-hospital death, major bleeding requiring surgical intervention, arteriovenous fistula requiring vascular surgery, thromboembolic event, and permanent atrioventricular block, among others. Among the major complications, cardiac perforation is one of the most life-threatening scenarios and occurred in 1.2%-1.7% of the patients receiving EPS or catheter ablation. It is usually acute onset for cardiac perforation following EPS or catheter ablation and would be detected by unstable hemodynamics or symptoms and signs of heart failure occurring in the CL or in the ICU. Delayed onset is relatively rare, and the incidence rate of delayed cardiac tamponade after catheter ablation was 0.16% as reported by a worldwide survey. Delayed-onset cardiac perforation can even occur 9 months after catheter ablation. Acute onset of cardiac perforation following catheter ablation or EPS usually leads to immediate hemodynamic compromise. However, for the patients with delayed onset of cardiac perforation, there are different presentations, such as sepsis or neurological deficit due to LA esophageal fistula or LA bronchial fistula in addition to hypotension. It is usually insidious for delayed onset of cardiac perforation, but it is still possible to be
Table II. Preoperative Hemodynamics, Ruptured Sites, Surgical Procedures, and Outcomes of Patients with Cardiac Perforation Following Catheter Ablation or Electrophysiology Treated by Surgical Repair

| Author        | Age/sex | Hemodynamics | Ruptured site | PreOP CPR | Surgical procedure                          | Outcome        |
|---------------|---------|---------------|---------------|-----------|---------------------------------------------|----------------|
| Tsang(5)      | 75/M    | Collapse      | LV            | NA        | Repair of LV                                | Survived       |
|               | 68/F    | Collapse      | Not found     | NA        | Removal of clots                            | Died           |
|               | 85/F    | Collapse      | Not found     | NA        | Removal of clots                            | Survived       |
|               | 33/F    | Tamponade     | Not found     | NA        | Removal of clots                            | Survived       |
|               | 78/F    | Collapse      | LV            | NA        | Repair of LV                                | Survived       |
|               | 87/F    | Collapse      | Not found     | NA        | RV repair and removal of clots              | Survived       |
|               | 59/F    | Collapse      | RV            | NA        | RV repair and ICV repair                    | Survived       |
|               | 75/F    | Collapse      | Not found     | NA        | Removal of clots                            | Survived       |
| Hsu(9)        | 67/M    | Collapse      | LV P wall     | Y         | Suture repair of LV (w/CPB)                 | Survived       |
| Kono(10)      | 61/F    | Hypotension   | LV PL wall    | No        | Suture repair of LV (w/CPB)                 | Survived       |
| Bunch(1)      | 48/M    | Collapse      | LA dome       | NA        | Suture repair of LA                         | Survived       |
|               | 70/F    | Collapse      | LA dome       | NA        | Suture repair of LA and maze                | Survived       |
| Bahcivan(12)  | 42/F    | Hypotension   | LA dome       | No        | Suture repair of LA                         | Survived       |
| Jimenez(13)   | 69/M    | Hypotension   | LV            | No        | Suture repair of LV                         | Survived       |
| Tokuda(14)    | 49/F    | Collapse      | RVOT          | Y         | Suture repair of RV (w/o CPB)               | Survived       |
|               | 41/M    | Collapse      | RVOT          | Y         | Suture repair of RV (w/CPB), IABP, BVAD, HTX| Survived       |
|               | 67/F    | Hypotension   | RVOT          | N         | Suture repair of RV (w/o CPB)               | Survived       |
|               | 45/F    | Collapse      | RVOT          | Y         | Suture repair of RV (w/o CPB)               | Survived       |
|               | 87/M    | Collapse      | RV free wall  | Y         | Suture repair of RV (w/CPB), cryoablation,  | Survived       |
|               |         |               |               |           | IABP                                        |                |
| Huang(15)     | 67/M    | Hypotension   | LV PL wall    | N         | Suture repair of LV (w/CPB), AVR, LVAD      | Survived       |
|               | NA      | Hypotension   | RV A wall     | NA        | Suture repair of RV anterior wall           | Survived       |
| Nagamine(16)  | 69/M    | Hypotension   | LV P wall     | No        | Suture repair of LV (w/CPB)                 | Survived       |
| Vergara(17)   | 74/M    | PEA           | RA            | Y         | Suture repair of RA                         | Survived       |
| Liu(18)       | 64/M    | Hypotension   | LA dome, LAA, RA | No        | Suture repair of LA (w/CPB)                 | survived  |
| Fiore(19)     | 84/M    | Collapse      | RV free wall  | Y         | Failed suture repair due to fragility of the myocardium | Survived       |
| Hirata(20)    | 70/F    | Hypotension   | LV P, AV groove, LA dissection | N | Suture repair of LV and LA (w/CPB) | Died |
| Oz(21)        | 45/M    | Hypotension   | LV P wall     | N         | Suture repair of LV (CPB?)                  | Survived       |
| Cao(22)       | 61/M    | Hypotension   | LV PL wall    | N         | Suture repair of LV (w/CPB): suture + patch + glue | Survived       |
| Majovic(23)   | 64/M    | EMD/VF        | LA P wall     | NA        | Fibrin glue application around lateral PVs   | Survived       |
|               | 60/M    | EMD           | LAA-LSPV ridge | NA        | Suture repair of mitral isthmus (CPB?)       | Survived       |
| Yeter(24)     | 57/M    | CMA           | Vein          | Y         | Removal of clots and blood                  | Survived       |
| Schuring(25)  | 72/M    | Hypotension   | LA-E fistula  | N         | LA repair                                   | Died           |
|               | 71/M    | Sepsis        | LA-E fistula  | N         | LA repair (w/CPB)                           | Survived       |
|               | 75/M    | Hypotension   | RPV-E fistula, RV | N | Repair of RV                               | Died           |
|               | 32/F    | Right hemiplegia | LA-B fistula  | N         | Repair of LA and bronchus (w/CPB)           | Survived       |
| Velghe(26)    | 32/F    | Right hemiplegia | LA-B fistula  | N         | Repair of LA and bronchus (w/CPB)           | Survived       |
| Gennari(27)   | 64/M    | Tamponade     | LV inferior wall | No | Repair with LV: Bioglue + Hemopatch (w/CPB, IABP, gauze packing) | Survived       |
| Siliato-Robles(28) | 23/M | Tamponade     | IVC-RA junction | No | Repair with bovine pericardial patch (w/CPB) | Survived       |
| Shenthar(29)  | 70/M    | Persistent bleeding | RV, inferior-apical | No | Repair of RV + epicardial cryoablation | Survived       |

Collapse indicates systolic blood pressure < 60 mmHg; RV, right ventricle; RVOT, right ventricular outflow tract; LV, left ventricle; PL, posterolateral; P, posterior; LA, left atrium; LAA, left atrial appendage; AV groove, atrioventricular groove; AVR, aortic valve replacement; E, esophagus; B, bronchus; RPV, right pulmonary vein; LSPV, left superior pulmonary vein; RA, right atrium; IVC, inferior vena cava; CVP, cardiopulmonary bypass; IABP, intra-aortic balloon pump; LAD, left anterior descending coronary artery; LVAD, left ventricular assist device; BVAD, biventricular assist device; HTX, heart transplantation; and CPR, cardiopulmonary resuscitation.

Presented as sudden collapse. Thus, patients with arrhythmias treated by catheter ablation should be followed up carefully because delayed cardiac perforation is still possible even several months after catheter ablation.

Regarding the management of cardiac perforation following EPS or catheter ablation, there are four treatments of choice published in the literatures, namely, conservative treatment,4,8 pericardiocentesis, interventional treatment with closure device,20 and surgical treatment. The majority of patients with cardiac perforation were treated with pericardiocentesis11,14,32 at first to relieve cardiac tamponade rather than open surgical repair. Pericardiocentesis and concomitant medical management could stabilize most of the patients with cardiac perforation following catheter ablation or EPS, which means that the cardiac perforation caused by catheter possibly sealed off spontaneously and
Figure 2. Schematic algorithm to summarize the surgical approach for cardiac perforation following catheter-related procedures.

the patients could be stabilized by drainage of the blood in the pericardial space to relieve cardiac tamponade and by medical therapy to achieve hemostasis. Therefore, surgical repair seems not to be thought as the first-line treatment modality for cardiac perforation induced by catheter-related procedures, resulting only in sporadic reports or small series relevant to surgical repair published in the literatures. To the best of our knowledge, there are still no large series or review articles currently to investigate how to manage this issue by surgery. Thus, due to limited surgical experiences, it is challenging for surgeons to decide how to solve this complication surgically. However, if surgical repair for cardiac perforation is necessary after rescue pericardiocentesis is done, it could be very emergent and critical as there should be persistent bleeding from the perforation site of the heart or cardiac tamponade could not be relieved effectively. Moreover, due to limited experience of surgical repair for cardiac perforation following EPS or catheter ablation under such an emergent circumstance, it might not be very easy for surgeons to choose the best surgical procedure immediately for every single patient. In fact, before deciding how to repair the heart, it
may be more stressful to check where the heart is ruptured, especially when bleeding is suspected from the posterior aspect of the heart. Some surgeons may worry whether the condition of the perforation site may aggravate by manipulating the heart during surgery.

This systemic review collected surgical experiences for cardiac perforation caused by catheter ablation or EPS published from 1998 to 2020, in which there are several surgical strategies used to treat cardiac perforation, including removal of clots only, suture repair, glue application, and combination of suture and glue with or without cardiopulmonary bypass (CPB). In general, when it comes to surgical procedures, the chest is opened at first, and then blood clots are removed. It depends on preoperative hemodynamics to decide whether CPB setup is necessary before opening the chest. If no further bleeding from the heart is seen after removal of blood and clots in the pericardial cavity, chest wall may be closed after thorough inspection of the entire heart could be done to make sure the perforation site of the heart is sealed off or to suture some stitches to secure the perforation site caused by catheters. However, over-manipulation of the heart may be possible to cause unexpectedly catastrophic bleeding. If active bleeding is seen after removal of blood and clots in the pericardial cavity, it depends on surgeon’s judgment to decide whether to set up CPB before cardiac repair. CPB may not be necessary if the perforation site is easy to approach, and the hemodynamics is acceptable before cardiac repair is completed. CPB should be set up for cardiac repair if the perforation site is difficult to approach and the hemodynamics is unstable. If CPB is used for cardiac repair, it depends on surgeon’s judgment to decide whether cardiac arrest by cardioplegia is necessary. Cardiac arrest by cardioplegia may be necessary if thorough inspection is needed to check the extent of the cardiac perforation, and accurate plus precise repair could be accomplished afterward. Regarding cardiac repair, suture repair is usually used by cardiac surgeons, but sutureless repair may be considered if the perforation site is very fragile or is very close to the coronary arteries. Moreover, if penetration of cardiac chambers by catheters was found during catheter-related procedures, in addition to pericardiocentesis to relieve cardiac tamponade, it would be a good management to leave the catheter in situ and transfer the patient to the OR as soon as possible. For patients treated with sutureless repair, it would be better to follow up carefully since pseudoaneurysm possibly occurred later from the previous perforation site. Figure 2 shows the surgical approaches for cardiac perforation following catheter ablation or EPS.

Surgical repair for patients with such a life-threatening condition is a difficult task, and only successful treatments with surgical repair are prone to be reported in the literature. Nevertheless, this systemic review aims to collect surgical experiences for cardiac perforation following EPS or catheter ablation all around the world to help the surgeons who are consulted to treat the patients with such a critical condition.

Conclusion

Cardiac perforation following EPS or catheter ablation is a life-threatening situation which usually necessitates timely rescue intervention or surgery. Although the majority of patients are treated with pericardiocentesis and concomitant medical management at first, cardiovascular surgeons must prepare to take over if the bleeding is persistent or if the cardiac tamponade is not relieved. There are several surgical strategies which could be chosen for various scenarios of cardiac perforation if surgical repair is inevitable for saving lives.

Disclosure

Conflicts of interest: The authors declare no conflicts of interest.

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