

Mechanical displacement of the esophagus in patients undergoing left atrial ablation of atrial fibrillation

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Background

Left atrial (LA) ablation of atrial fibrillation (AF) may rarely be complicated by an atrio-esophageal fistula.

Objective

The purpose of this study was to determine the feasibility of mechanical displacement of the esophagus in patients undergoing LA ablation.

Methods

Twelve patients underwent mechanical displacement of the esophagus performed by an endoscopist during an LA ablation procedure under conscious sedation.

Results

The intrinsic course of the esophagus was near the left pulmonary veins (PVs) in 6 patients, the right PVs in 5 patients, and the mid-LA in 1 patient. In 10 (83%) of the 12 patients, the esophagus could be displaced with the endoscope. The maximal displacement toward the left-sided and right-sided PVs was 2.4 and 2.1 cm, respectively. In 2 (22%) of the 9 patients in whom a prior procedure was unsuccessful because of an unfavorable esophageal course, the esophagus remained at the same location to which it was displaced after removal of the endoscope, facilitating energy delivery at the target site. In the remaining 7 patients, the esophagus returned to its original location after the endoscope was removed. There were no complications related to the endoscopic procedure.

Conclusion

The esophagus can be mechanically displaced with an endoscope during an LA ablation procedure under conscious sedation. However, in most patients, the esophagus assumes its original course after removal of the endoscope. In some patients in whom PV isolation is problematic because of an unfavorable esophageal course, endoscopic displacement may facilitate safe energy delivery over the posterior LA.

Keywords: [Esophagus](#), [Atrial fibrillation](#), [Catheter ablation](#), [Complications](#)

Article Outline

Catheter ablation of atrial fibrillation (AF) is rarely complicated by thermal injury to the esophagus, often resulting in death.^{1, 2} Real-time imaging of the esophagus (e.g., by barium swallow³) allows the operator to identify the position of the esophagus so as to avoid delivery of radiofrequency energy at sites in the posterior

left atrium (LA) that could result in esophageal injury. The intimate relationship of the esophagus with either the left-sided or right-sided pulmonary veins (PVs)⁴ occasionally interferes with the ability to safely achieve complete PV isolation,⁵ which may result in inefficacy and the need for repeat procedures.

Because the esophagus is a mobile structure, it is conceivable that it may be located at a more favorable location during a repeat session, thereby allowing for the completion of the originally intended lesion set. However, a recent study showed that in patients presenting for a repeat ablation procedure, the esophagus is at the same location relative to the LA as it was during the first procedure in nearly 85% of cases.⁶ A study of three patients under general anesthesia showed that the esophagus could be displaced with a transesophageal echocardiography probe to facilitate energy delivery at the posterior LA.⁷ The current study was conducted to explore the feasibility of the technique in patients undergoing the ablation procedure under conscious sedation.

Methods

The study was approved by the institutional review board at the University of Michigan. Informed consent for both the ablation procedure and endoscopy was obtained from the 12 patients who participated in the study. Patients with a history of gastroesophageal reflux disease, esophageal stricture, or other contraindications to endoscopy were excluded from the study. The demographic characteristics of the patients are listed in [Table 1](#). The first three patients underwent the study to demonstrate the feasibility of esophageal displacement. The subsequent nine patients were invited to participate in the study because of incomplete PV isolation and recurrent AF due to an unfavorable LA–esophageal relationship during a prior ablation procedure. The target sites where ablation was avoided because of the position of the esophagus during the initial procedure in these nine patients were the left PVs in 5, the right PVs in 3, and the mid-posterior LA in 1.

Table 1.

Patient characteristics

No. of patients	12
Age (years)	63 ± 7
Males/females	9/3
Paroxysmal/persistent atrial fibrillation	5/7
Left ventricular ejection fraction (%)	53 ± 5
Left atrial diameter (mm)	45 ± 6

The electrophysiologic procedure was guided by a three-dimensional electroanatomic mapping system (CARTO, Biosense Webster, Diamond Bar, CA, USA). Radiofrequency energy was delivered using a 3.5-mm-tip, open irrigation ablation catheter (ThermoCool, Biosense Webster). For patients with paroxysmal AF, antral PV isolation was performed with the end-point of noninducibility of AF during isoproterenol infusion. For patients with persistent AF, the procedure consisted of antral PV isolation and ablation of complex atrial electrograms and/or linear ablation with the end-point of AF termination. Radiofrequency energy was delivered with a maximal power of 25 W along the posterior LA, 30 to 35 W at the anterior wall/septum, and 20 W in the coronary sinus. The catheter was moved every 20 to 30 seconds during energy delivery or when the local atrial electrogram was abolished.

Esophageal displacement

Catheter ablation and endoscopy were performed under conscious sedation. After completion of the three-

dimensional map of the LA, esophageal intubation was performed by a gastroenterologist (TN or JR) under direct visual guidance with a standard endoscope (GIF-H180, Olympus, Center Valley, PA, USA). With the endoscope positioned in the distal esophagus, the tip was flexed approximately 90° using the controls on the head of the endoscope, resulting in bowing of the endoscope proximal to the tip ([Figure 1](#)). If adequate displacement was not achieved, the endoscope was repositioned 5 to 10 cm proximal to the gastroesophageal junction, and repeat bowing was performed. Optimal positioning of the endoscope was confirmed fluoroscopically to ensure that the segment of esophagus immediately overlying the LA was targeted for manipulation. The endoscope body then was torqued clockwise and/or counterclockwise by manual grasping, thereby displacing the esophagus with the bowed endoscope.

Figure 1. Cinefluoroscopic views during endoscopic displacement of the esophagus in the anteroposterior view. **A, C:** Maximal (max) rightward and leftward course of the esophagus, respectively, as a result of mechanical displacement. **B:** Intrinsic esophageal course, which is slightly left of the spinous processes (*dashed white line*). The ablation catheter, a ring catheter, and a catheter placed in the coronary sinus (CS) also are visualized. The cinefluoroscopic projection is the same in all the panels.

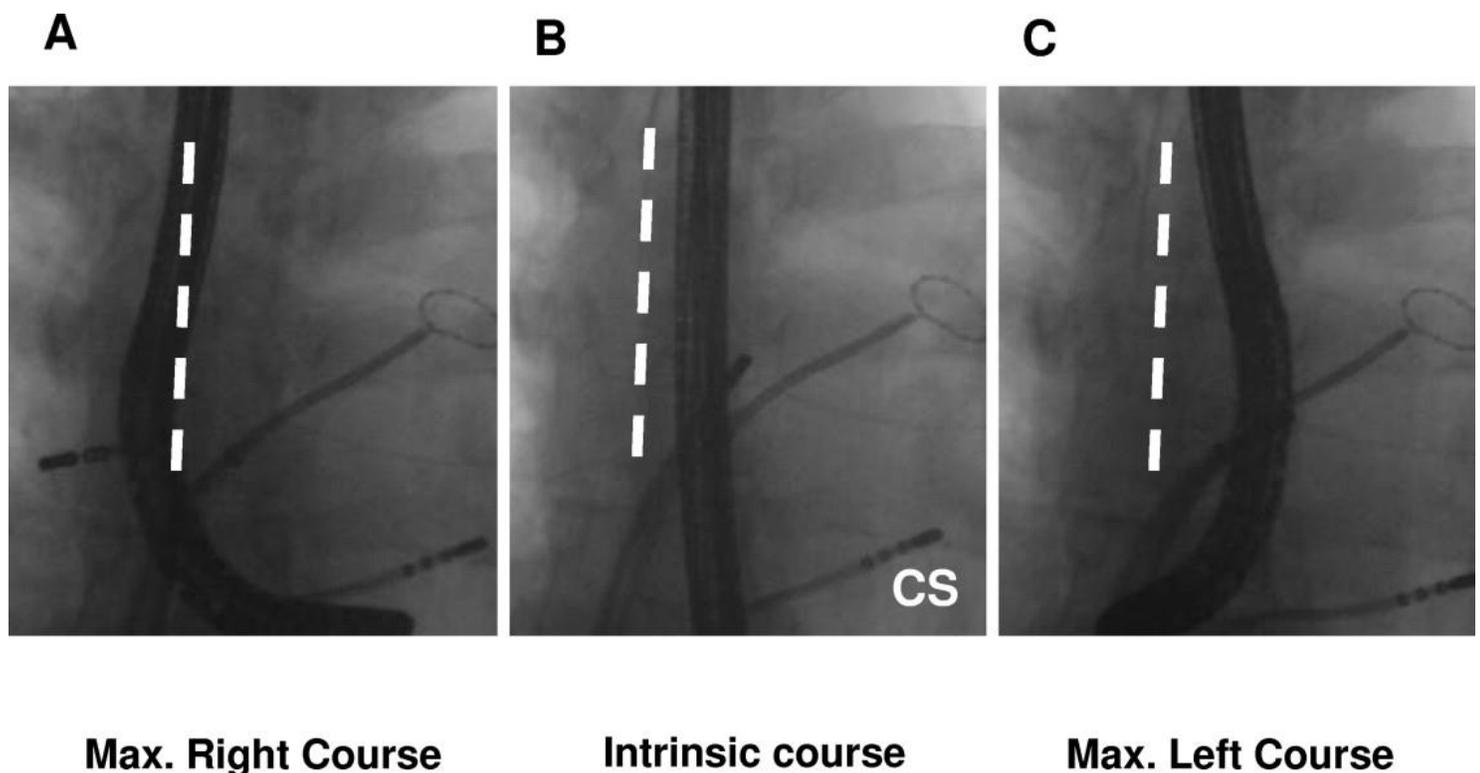


Fig. 1

Cinefluoroscopic images were recorded during the initial introduction of the endoscope into the esophagus (intrinsic course) and during maximal leftward and rightward esophageal displacement. After the endoscopic procedure, either an orogastric tube was inserted or 3 mL of barium paste (E-Z-Paste, E-Z-EM Canada Inc., Westbury, NY, USA) was administered orally, depending on the patient's level of consciousness. Prior to radiofrequency energy delivery, the endoscope was removed to decrease the risk of mechanical complications,⁸ to eliminate the possibility of shunting radiofrequency energy toward the endoscope in the esophagus, and because it was physically awkward for the endoscopist to continually apply torque to the endoscope during energy delivery along the posterior LA.

Results

The initial course of the esophagus was near the left-sided PVs in 6 patients, near the right-sided PVs in 5 patients, and posterior to the mid-LA in 1 patient. In 10 (83%) of the 12 patients, the esophagus was displaceable with the endoscope ([Figure 1](#), [Figure 2](#)). The maximal displacement toward the left-sided and right-sided PVs was 2.4 and 2.1 cm, respectively. In 2 (22%) of the 9 patients in whom a prior procedure was unsuccessful because of an unfavorable esophageal course, the esophagus remained at the same location to which it was displaced after removal of the endoscope, facilitating energy delivery at the target site ([Figure 3](#)). In the remaining 7 patients, the esophagus returned to its original location after the endoscope was removed. There were no complications related to the endoscopic procedure and no instances of atrio-esophageal fistula.



Figure 2. Electroanatomic three-dimensional map of the left atrium corresponding to [Figure 1](#), shown in the posteroanterior view. *Pink tags* show the intrinsic course of the esophagus. During maximal rightward displacement (*blue tags*), the esophagus was located 1.8 cm away from the baseline course. During maximal leftward torque, the esophagus was displaced 2.4 cm toward the left-sided pulmonary veins (*white tags*). LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.

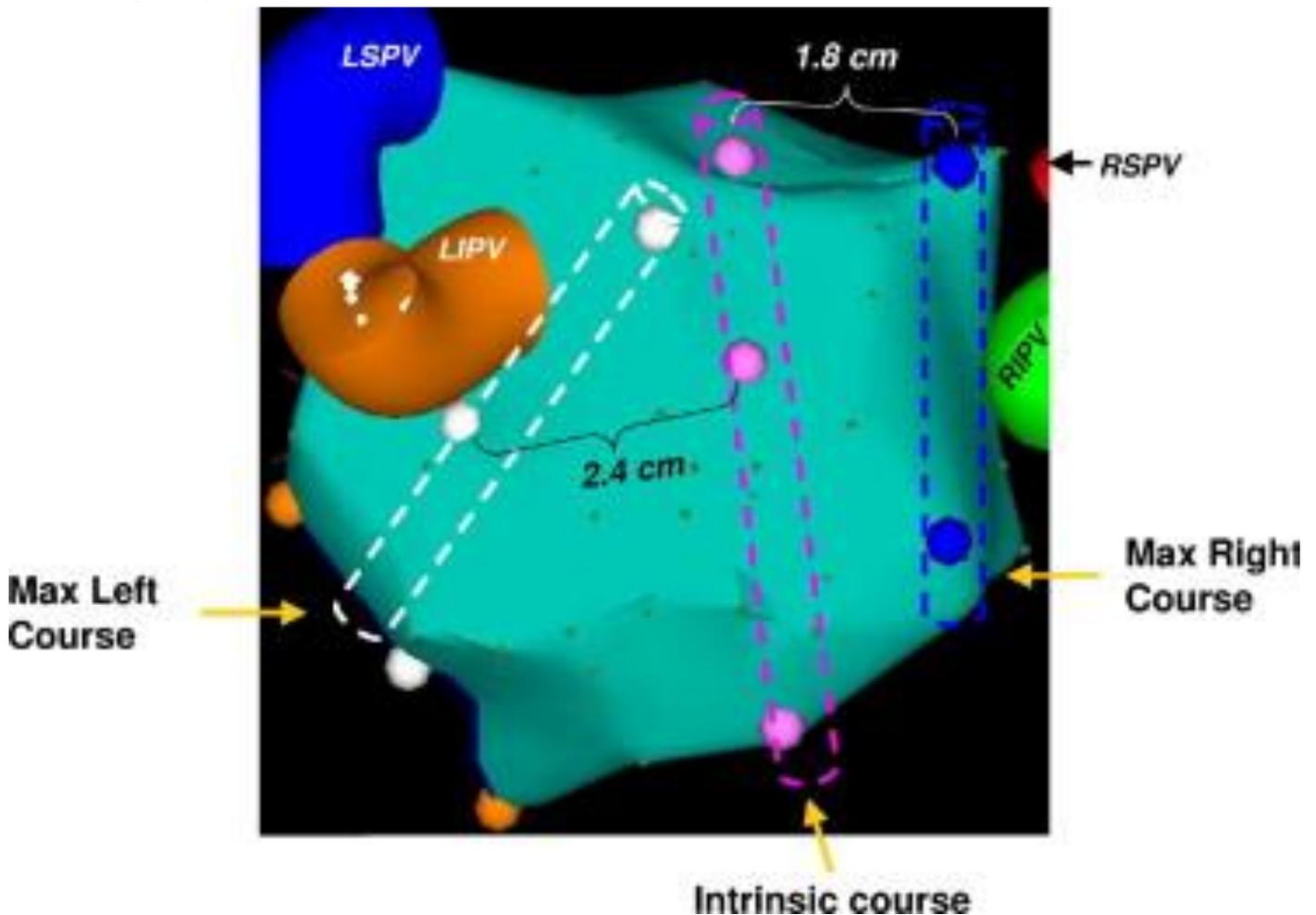


Fig. 2

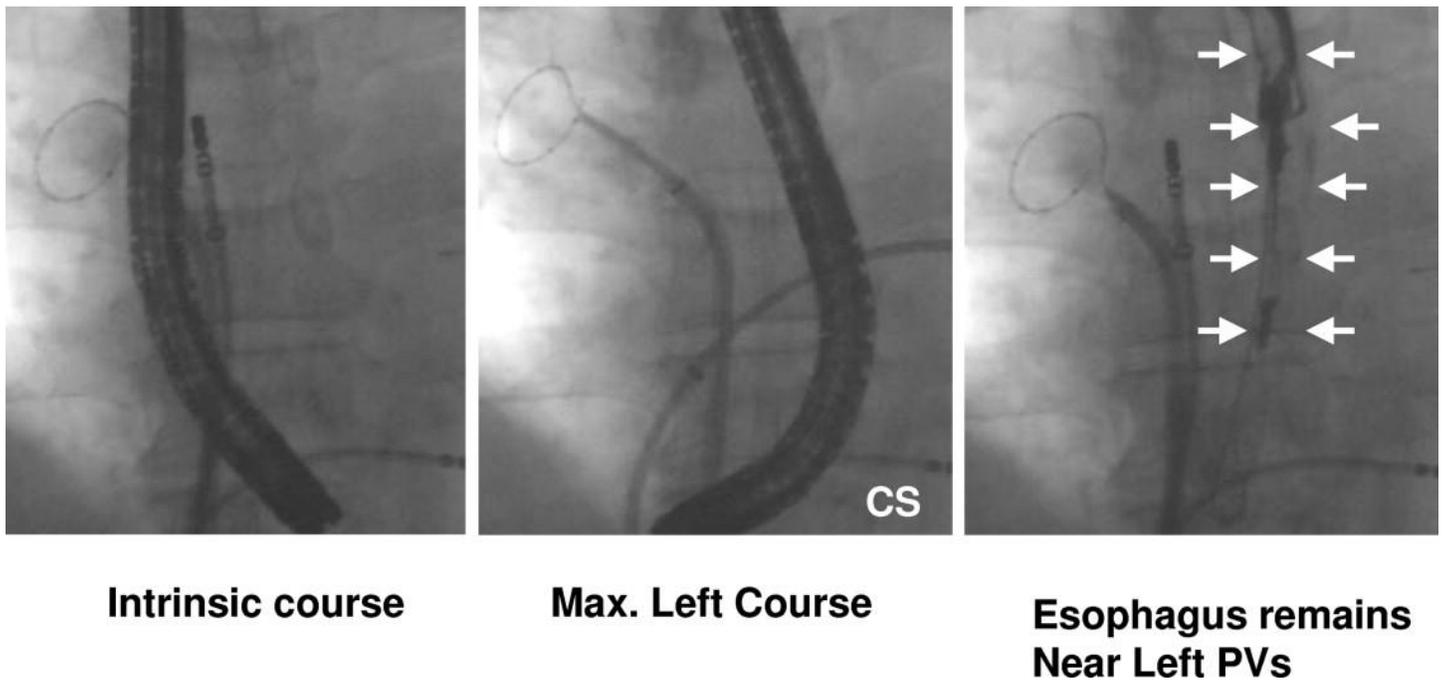


Fig. 3

Figure 3. Facilitating radiofrequency energy delivery over the posterior left atrium near the right-sided pulmonary veins (PVs). This patient with chronic atrial fibrillation had failed a prior procedure, at least in part because the right-sided PVs were not completely isolated due to the course of the esophagus. During the repeat session, the intrinsic course of the esophagus again was near the right PVs (A). The esophagus then was displaced by more than 2 cm toward the left PVs (B). After the endoscope was removed, an orogastric tube was inserted and barium administered (arrows, C). The esophagus remained near the left PVs, allowing for complete isolation of the right PVs in safe manner (C). CS = coronary sinus.

Discussion

Main findings

In the majority of patients in whom incomplete isolation of the PVs is attributable to an unfavorable esophageal course, mechanical displacement of the esophagus to allow safe radiofrequency ablation is feasible. Displacement of the esophagus away from the intended target site for ablation facilitates the safe delivery of radiofrequency energy and may improve the outcome of the procedure in patients who otherwise are likely to have recurrent AF. The endoscopic procedure can be performed under conscious sedation and was well tolerated by the patients in this study.

Esophageal displacement

In most patients in this study, the esophagus could be displaced from its original position. The position of the thoracic esophagus is not maintained by true ligaments but by sparse muscle fibers and fibroelastic membranes attached to the closely approximated mediastinal structures. Why the esophagus could not be displaced in all patients is not clear. Possible reasons include decreased laxity of attachments to surrounding structures, increased compliance of the esophageal wall resulting in distension of the esophageal lumen rather than translocation of body of the esophagus, and variations in technique. Another possibility is decreased compliance of the surrounding tissues, such as the PVs and/or their antra. In some patients, preprocedural LA imaging may reveal prominent bulbous antra that may serve as obstacles to esophageal displacement.

In most patients in this study, the esophagus assumed its original position after the endoscope was removed, as might be expected given the elastic nature of the esophageal wall and its connective tissues. Esophageal rebound to its original position might hinder the safe delivery of radiofrequency energy. A strategy for overcoming this limitation is delivery of radiofrequency current while the esophagus is being actively displaced with the endoscope. However, there is a theoretical concern of shunting radiofrequency energy to the endoscope, which could result in thermal injury to the esophagus. For this reason, radiofrequency energy applications were not delivered until the endoscope was removed from the esophagus. Although the endoscopes used in this study are encased in nonconducting material, the safety of radiofrequency energy delivery to the posterior LA while the endoscope is in the esophagus is unknown. Of note, in a small study of three patients, ablation was performed without evidence of esophageal injury while a transesophageal echocardiography probe was in the esophagus.⁷ Animal studies examining the conducting properties of endoscopes in the setting of LA ablation may be warranted.

In 2 of the 12 patients in this study, the esophagus remained at the location to which it was displaced even after removal of the endoscope. It is possible that, in these patients, the esophageal connective tissues are less elastic, or rebound may have been prevented by other mediastinal structures. In these patients, the posterior LA could be safely ablated because the esophagus remained away from the ablation target sites along the posterior LA.

Alternative approaches for avoiding esophageal injury

Numerous methods have been explored in an effort to minimize the risk of esophageal injury. These include abstinence from energy delivery over the visualized esophagus via a barium swallow³ or radiopaque marker in the esophagus,⁹ esophageal temperature monitoring,¹⁰ identification of the course of the esophagus using intracardiac echocardiography¹¹ or preprocedural three-dimensional imaging, and preprocedural and postprocedural treatment with proton pump inhibitors.¹² Each of these techniques has its drawbacks, but some form of esophageal surveillance probably is better than none in an effort to avoid severe complications. Esophageal displacement is another option that is available for minimizing the risk of esophageal injury.

Study limitations

A major limitation of the technique described in this study is the uncertainty as to whether the esophagus is simply being stretched or actually is displaced *in toto* during endoscopic displacement. If the former is the case and radiofrequency energy is delivered, there may be ongoing risk of thermal injury to the esophagus. At least in two patients in this study, the esophagus actually was displaced *in toto* rather than simply stretched, as visualized by real-time imaging (Figure 3), allowing for safe delivery of radiofrequency energy. However, repeat endoscopy was not performed after the procedure in these patients to determine whether ablation over the target site resulted in “subclinical” thermal injury to the esophagus.

The requirement for the presence of an endoscopist during the ablation procedure is another drawback. This shortcoming can be eliminated by electrophysiologists who are adept in transesophageal echocardiography. Because of the small but real risk of esophageal tear and perforation during endoscopy/transesophageal echocardiography,¹³ esophageal manipulation likely is best left to trained endoscopists.

Another limitation is the actual time that the displaced esophagus must be held away from the target site. Specifically, the gastroenterologist must hold the endoscope in the same position for the several minutes required to perform ablation along the posterior LA wall, which may be especially cumbersome during fluoroscopic imaging in the left anterior oblique position.

Conclusion

Mechanical displacement of the esophagus is feasible in most patients undergoing catheter ablation of AF. However, in most patients, the esophagus assumes its original course after the endoscope is removed, preventing energy delivery over the target site. In some patients, the esophagus remains in the location to which it was displaced, allowing for safe delivery of radiofrequency energy over the posterior LA. Logistical issues, such as the need for an endoscopist to be present during the ablation procedure, may pose a practical limitation.

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