Mechanical Esophageal Deflection During Ablation of Atrial Fibrillation

BENGT HERWEG, NANCY JOHNSON, GILBERT POSTLER, ANNE B. CURTIS, S. SERGE BAROLD, and ARZU ILERCIL

From the Arrhythmia Service and Division of Cardiology, Tampa General Hospital and University of South Florida, Tampa, Florida

To prevent esophageal damage during ablation of atrial fibrillation, we developed a technique to move the esophagus away from a desired ablation site too close to the esophagus. Under fluoroscopy, a transesophageal echocardiography probe was used to deflect the barium-opacified esophagus from the ablation site. This technique was successfully employed in three patients where critical sites of the posterior left atrial wall were very close to the esophagus. (PACE 2006; 29:957–961)

atrial fibrillation*, *ablation*, *esophageal injury

Introduction

Esophageal injury is a serious and potentially life-threatening complication of ablative therapy for atrial fibrillation (AF).[1] The esophagus and posterior left atrial wall are in close contact over a large area that often lies within the ablation zone for both left atrial linear ablation and pulmonary vein (PV) isolation. The anatomic location of the esophagus exhibits marked variability and includes positions adjacent to the left PV ostia, the midportion of the posterior left atrium, and the right PV ostia.[2–6] Esophageal temperature monitoring and real-time imaging using barium contrast or computerized 3D mapping techniques may help in esophageal localization.[7–10] These techniques permit modification of energy delivery and ablation site but their efficacy and safety in preventing esophageal injury have not been established.[6–10]

Based on previous observations that under conscious sedation the esophagus is mobile and can shift sideways $\geq$2 cm,[11] we devised a technique to move the esophagus transiently away from a desired ablation site to prevent esophageal damage. Under fluoroscopy, a transesophageal echocardiography (TEE) transducer was used to deflect the barium-opacified esophagus away from the ablation site. This technique was successfully employed in three patients where critical sites of the posterior left atrial wall were very close to the esophagus.

Materials and Methods

Three out of six consecutive patients who underwent AF ablation over a 2-week period required ablation very close to the esophagus for ostial PV isolation. All six patients underwent endotracheal intubation and light general anesthesia with propofol. A duodecapolar catheter (Daig, Inc., Woodlan Hills, CA, USA) was placed into the coronary sinus. Intravenous heparin was given and the ACT was adjusted to 300–350 seconds. A double transseptal catheterization was performed and the ablation catheter (EP Technology, St. Jose, CA, USA, large curve, 8-mm tip) and the 20-pole circumferential mapping catheter (LASSO, Biosense-Webster, Inc., Diamond Bar, CA, USA) were introduced into the left atrium and selected PV. Five to 10 cc of barium paste (E-Z-Paste, E-Z-EM Canada Inc., Westbury, NY, USA) was introduced into the midesophagus via an orogastric tube. Earliest PV potentials were targeted for ablation. Once targets close to the opacified esophagus were encountered, a TEE transducer (Siemens, Medical Solutions, Malvern, PA, USA) was advanced to the lower esophageal sphincter. The probe was manipulated using flexion and rotation to achieve deflection of the opacified esophagus away from the tip of the ablation catheter. At sites close to the esophagus radiofrequency (RF) energy was delivered under fluoroscopy in the temperature-controlled mode (50°C) at power settings of 15–25 W with RF delivery time limited to 15–20 seconds. Ablation was carried out until there was complete loss or change in sequence of PV potentials on the LASSO catheter and significant reduction in electrogram amplitude on the ablation catheter. The TEE probe was then removed after successful ablation of sites near the esophagus.

All cine-fluoroscopic images were digitally analyzed on a computer. To allow comparison between images they were carefully aligned considering the respiratory cycle using landmarks such as the spinal borders and other projected structures.

Address for reprints: Bengt Herweg, M.D., Division of Cardiology, University of South Florida, Harbourside Medical Tower, Suite 630, Four Columbia Drive, Tampa, FL 33606. Fax: 813-259-0665; e-mail: bherweg@hsc.usf.edu

Received March 30, 2006; revised June 3, 2006; accepted June 12, 2006.

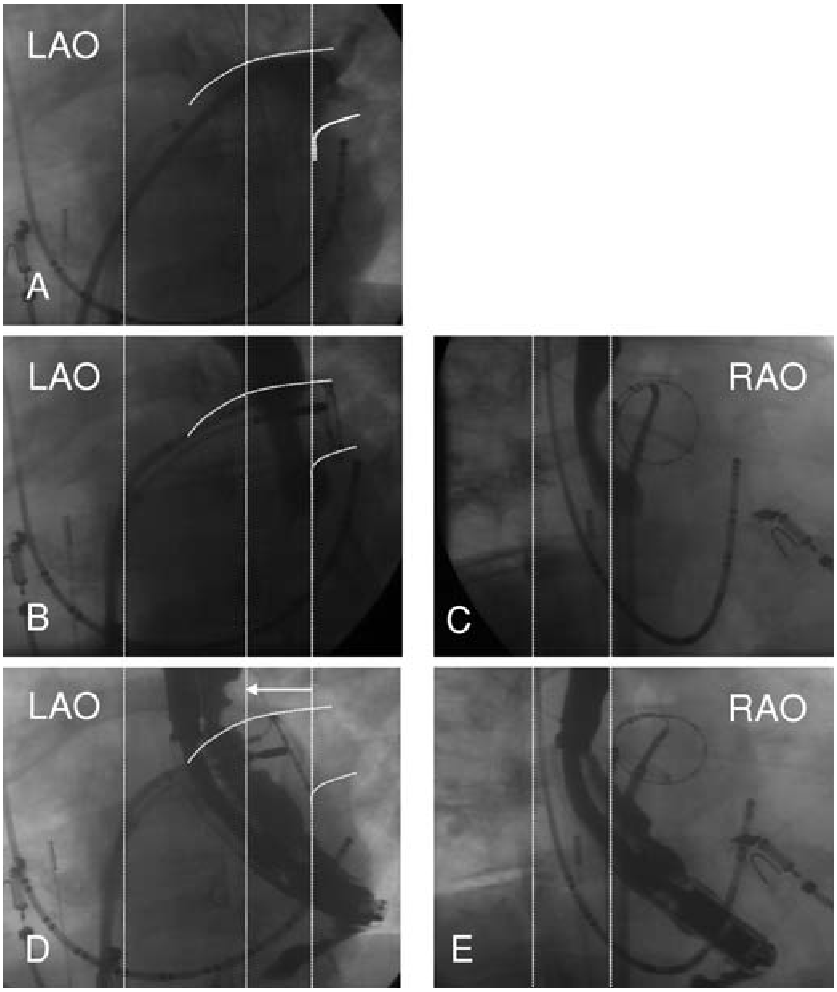

Figure 1. *Fluoroscopic images from patient 1 in LAO (40°) and RAO (30°) projections. The left vertical line in each image serves to align the left spinal border in LAO projections and the right sternal border in RAO projections. Panel 1A (upper row) shows a radiocontrast injection into the left common PV trunk in the LAO projection. An esophageal temperature probe is near the PV ostium. Panels 1B and 1C (middle row) show the Lasso catheter and ablation catheter in the left common PV projected on the barium-opacified esophagus in LAO and RAO views. There were extensive left atrial to PV connections in the posterior portion of the common PV ostium requiring ablation in areas close to the esophagus. Panels 1D and 1E (bottom row) show a TEE probe in the LAO and RAO projections deflecting the esophagus for safer RF energy application at sites no longer in direct esophageal contact. In patient 1 medial esophageal deflection of ≈1.5 cm allowed more proximal ostial isolation of the common PV trunk indicated by better catheter position in the LAO projection (1B compared to 1D). In the RAO projection the distance between the ablation catheter and the esophagus only increased by ≈0.2 cm (panel 1C compared to 1E). LAO = left anterior oblique; PV = pulmonary vein; RAO = right anterior oblique; TEE = transesophageal echocardiography.*

Horizontal movement of the esophageal border close to the desired ablation site was measured in both right and left anterior oblique planes at the level of the ablation catheter tip. To account for magnification errors measurements were based on electrode spacing of the catheters and diameter of the Lasso catheter. Results are displayed in Figures 1–3. The right and left anterior oblique images demonstrate maximal esophageal movement in the left anterior oblique projection (all critical ablation sites close to the esophagus were in the area of the left-sided PV ostia).

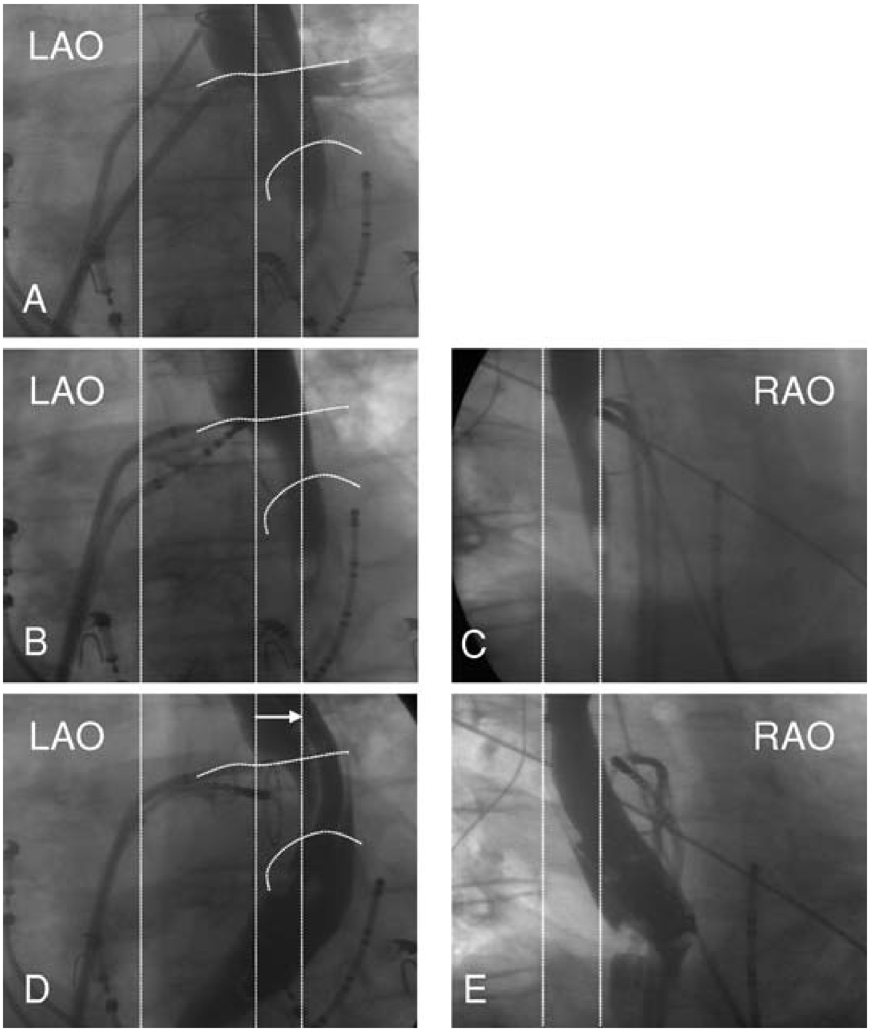

Figure 2. *Format similar to* Figure 1. *Panel 2A (upper row) shows a radiocontrast injection into the left inferior PV in LAO projection (Lasso catheter in the left upper PV). Panels 2B and 2C (middle row) show the Lasso catheter and the ablation catheter in the left inferior PV ostium. The ablation catheter projects directly onto the barium-opacified esophagus in both projections. In patient 2, the esophagus was displaced laterally by ≈1.0 cm allowing ostial isolation of the left inferior PV (2B compared to 2D). In the RAO projection (panel 2E) only minimal posterior displacement of the esophagus is noted. LAO = left anterior oblique; PV = pulmonary vein; RAO = right anterior oblique.*

Discussion

Mechanical deflection of the esophagus away from a desired ablation site may allow safer delivery of RF energy in the posterior left atrium during AF ablation and prevent thermal esophageal damage. In our three cases, the primary operator judged that the closeness of the esophagus to the required ablation site precluded safe energy delivery. We used a TEE transducer to deflect the barium-opacified esophagus under fluoroscopy. In all patients, we increased significantly the distance from the esophagus to the ablation catheter permitting application of RF energy at critical sites of the posterior left atrial wall initially very close to the esophagus. No patient showed clinical evidence of esophageal injury. Mild pharyngeal edema occurred in one of the patients. To avoid barium aspiration, the procedure was performed after endotracheal intubation. TEE itself carries a risk of esophageal injury. However, this risk is low even in patients undergoing cardiopulmonary bypass surgery under full anticoagulation (0.18%).[12] The risk-benefit ratio of our technique of esophageal deflection remains to be defined in patients

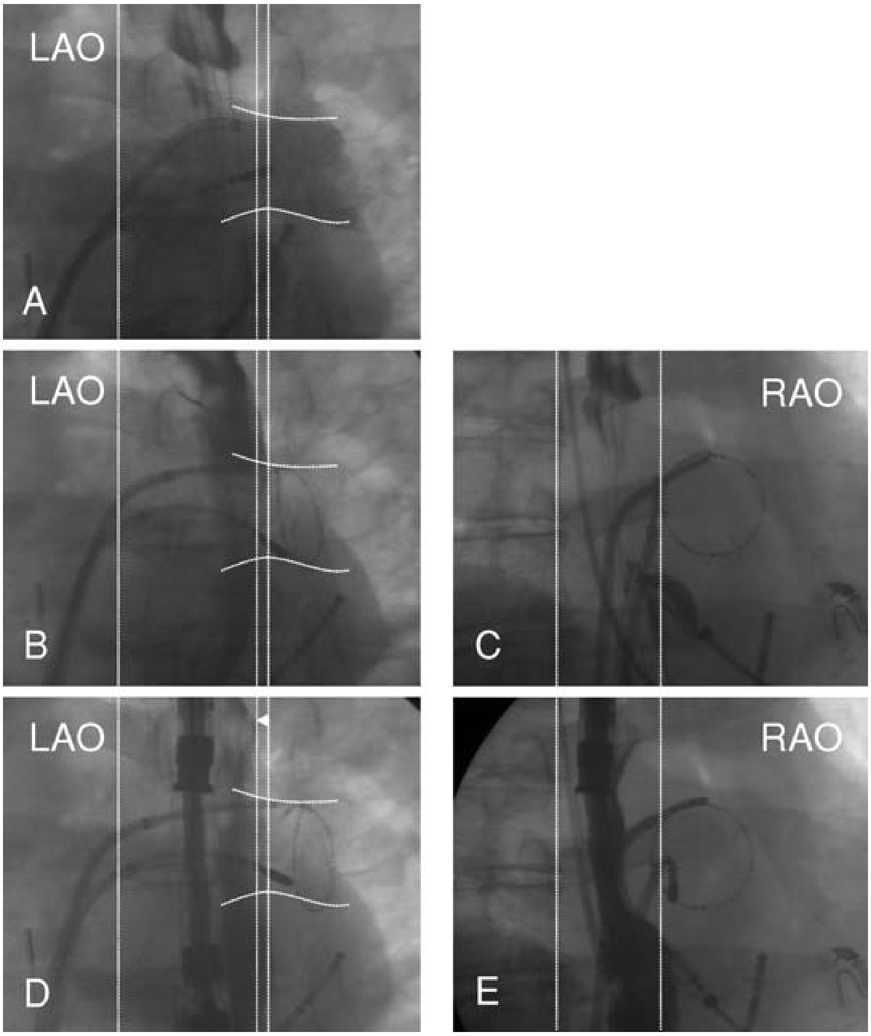

Figure 3. *Format similar to Figures 1 and 2. Panel 3A (upper row) shows a radiocontrast injection into the left common PV trunk in LAO projection. Panels 3B and 3C (middle row) show the Lasso catheter and ablation catheter in the left common PV ostium. The ablation catheter projects onto the edge of the barium-opacified esophagus in the LAO projection (panel 3B) and close (≈0.6 cm) to the esophagus in the RAO projection (panel 3C). In patient 3, only ≈0.3 cm of medial movement of the lateral esophageal silhouette provided safer RF delivery in the posterior aspect of the distal common PV trunk (panel 3B compared to 3D); proximity of the esophagus to the left common PV ostium interfered with more ostial isolation. In the RAO projection (panel 3C compared to 3E) no significant displacement of the esophagus is noted. LAO = left anterior oblique; PV = pulmonary vein; RAO = right anterior oblique.*

considered at risk of esophageal injury from RF energy. This technique will require further study, refinement, and the development of more suitable equipment.

References

1. Pappone C, Oral H, Santinelli V, et al. Atrio-esophageal fistula as a complication of percutaneous transcatheter ablation of atrial fibrillation. Circulation 2004; 109:2724–2726.
2. Lemola K, Sneider M, Desjardins B, et al. Related articles, links computed tomographic analysis of the anatomy of the left atrium and the esophagus: Implications for left atrial catheter ablation. Circulation 2004; 110:3655–3660.
3. Tsao HM, Wu MH, Higa S, et al. Anatomic relationship of the esophagus and left atrium: Implication for catheter ablation of atrial fibrillation. Chest 2005; 128:2581–2587.

4. Cury RC, Abbara S, Schmidt S, et al. Relationship of the esophagus and aorta to the left atrium and pulmonary veins: Implications for catheter ablation of atrial fibrillation. Heart Rhythm 2005; 2:1317–1323.
5. Kottkamp H, Piorkowski C, Tanner H, et al. Topographic variability of the esophageal left atrial relation influencing ablation lines in patients with atrial fibrillation. J Cardiovasc Electrophysiol 2005; 16:146–150.
6. Sanchez-Quintana D, Cabrera JA, Climent V, Farre J, Mendonca MC, Ho SY. Anatomic relations between the esophagus and left atrium and relevance for ablation of atrial fibrillation. Circulation 2005; 112:1400–1405.
7. Redfearn DP, Trim GM, Skanes AC, Petrellis B, Krahn AD, Yee R, Klein GJ. Esophageal temperature monitoring during radiofrequency ablation of atrial fibrillation. J Cardiovasc Electrophysiol 2005; 16:589–593.
8. Berjano EJ, Hornero F. A cooled intraesophageal balloon to prevent thermal injury during endocardial surgical radiofrequency ablation of the left atrium: A finite element study. Phys Med Biol 2005; 50:N269–N279.
9. Cummings JE, Schweikert RA, Saliba WI, et al. Assessment of temperature, proximity, and course of the esophagus during radiofrequency ablation within the left atrium. Circulation 2005; 112:459–464.
10. Pollak SJ, Monir G, Chernoby MS, Elenberger CD. Related articles, links novel imaging techniques of the esophagus enhancing safety of left atrial ablation. J Cardiovasc Electrophysiol 2005; 16:244–248.
11. Good E, Oral H, Lemola K, et al. Movement of the esophagus during left atrial catheter ablation for atrial fibrillation. J Am Coll Cardiol 2005; 46:2107–2110.
12. Daniel WG, Erbel R, Kasper W, et al. Safety of transesophageal echocardiography: A multicenter survey of 10,419 examinations. Circulation 1991; 83:817–821.