A New Epicardial Lesion Set for Minimal Access Left Atrial Maze: The Dallas Lesion Set

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A New Epicardial Lesion Set for Minimal Access Left Atrial Maze: The Dallas Lesion Set

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Purpose. **Improvements in enabling technology have facilitated minimal access techniques to the surgical ablation of atrial fibrillation. A variety of lesion sets (usually targeting only the left atrium) have been used in attempts to ablate atrial fibrillation. We describe a new epicardial approach to apply a set of left atrial lesions, which are electrophysiologically equivalent to all the left atrial lesions of the Cox maze III while using minimal access techniques.**

Description. **Using minimal access techniques, we have isolated the pulmonary veins and made connecting lesions on the dome of the left atrium to create a set of lesions electrophysiologically equivalent to all the left atrial lesions of the Cox maze III. Intraoperative electrophysiological evaluation is used to insure complete isolation across each lesion line.**

Evaluation. **Using these minimal access procedures, we have obtained a complete block across all lesion lines in all patients.**

Conclusions. **These techniques have made it possible to perform the full Cox maze III left atrial lesion set with minimal access techniques.**

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The feasibility of a minimal access approach to the surgical ablation of atrial fibrillation, consisting of bilateral wide pulmonary vein (PV) antral isolation, partial autonomic denervation (targeting selective fat pads containing autonomic ganglionated plexi), and selective left atrial appendectomy have been demonstrated [1–3]. Although this is efficacious for the treatment of paroxysmal atrial fibrillation, results are disappointing for patients with persistent and longstanding persistent (chronic) atrial fibrillation.

Technology

Because of the atrial electrical and structural remodeling that occurs in longstanding persistent atrial fibrillation, it is likely that a more extensive lesion set mimicking the Cox maze III left atrial lesions will be necessary for these patients [4, 5]. To do so, we added a connecting lesion between the superior aspect of the two antral lesions that encircle and isolate the right and left pulmonary veins and connecting lesions to the excision site at the base of the left atrial appendage and to the mitral valve annulus. The most challenging of these lesions to perform using a minimal access epicardial approach is the connecting lesion to the mitral annulus. In the Cox maze III operation, this lesion is usually created between the pulmonary vein encircling lesion (close to the right inferior pulmonary vein) and the posterior mitral annulus. In catheter ablation procedures, this lesion is most often created from the left inferior PV to the inferolateral mitral valve annulus (the mitral isthmus). However, when approaching the epicardium of the beating heart (off-pump) using minimally invasive techniques, there are three barriers to placing the mitral annulus connecting lesion at this site: (1) there is little to no visualization behind the left atrium when currently available techniques are used; (2) there is significant risk of damage to the circumflex coronary artery that frequently overlies the mitral valve; and (3) when using the coronary sinus as the landmark for the mitral annulus, these two landmarks may not coincide, being up to 13 mm separate [6], which risks making an incomplete connection, leading to macro re-entrant left atrial tachycardia [7, 8] Furthermore, the coronary sinus myocardial coat can provide an electrical bridge across the lesion if not ablated transmurally [9].

Some of the lesions in the original Cox maze III set were designed to prevent theoretical re-entrant circuits. Subsequent work has shown that the right atrial lesions of the Cox maze III are not necessary [4, 10].

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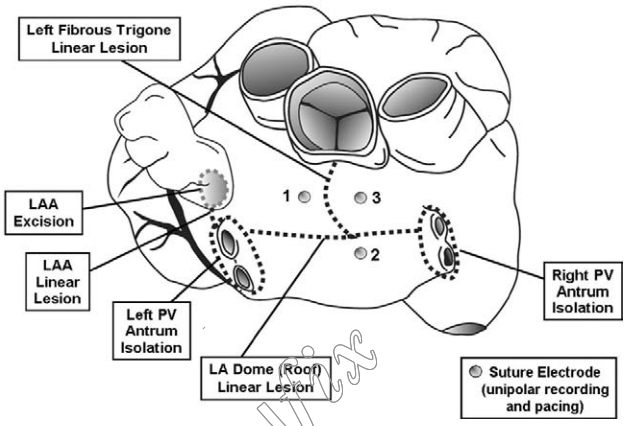

Fig 1. Location of the connecting lesions on the dome of the atrium, and position of the temporary pacing and recording electrodes. (LA = left atrial; LAA = left atrial appendage; PV = pulmonary vein.)

Technique

In the minimally invasive approach, we can obtain excellent visualization through the transverse sinus behind the aorta and the pulmonary artery. Therefore, we have begun placing all of our connecting lesions here on the dome of the left atrium (Fig 1). By working behind the superior vena cava and through the transverse sinus, we can place a transverse connecting lesion across the dome of the left atrium connecting the right superior PV with the left superior PV. It is then only a short extension of this line on the left side that connects it to the base of the left atrial appendage.

The connecting lesion to the mitral valve annulus can also be accomplished on the dome of the left atrium within the transverse sinus. The left fibrous trigone connects the mitral valve annulus to the aortic valve annulus at the aortic root. The left fibrous trigone meets the aortic valve at a point where the left coronary cusp and the noncoronary cusp join. Therefore, with good visualization, we can place this connecting lesion from the left fibrous trigone at the anterior mitral valve annulus across the anterior dome of the atrium to the transverse dome line. This line connecting to the fibrous triangle is made medially toward the center of the atrial dome. If the line is made laterally on the right side of the dome, it may cross the sinus node artery, which can affect activation of the left atrium during sinus rhythm, resulting in temporary sinus node dysfunction.

The bilateral PV antrum isolation and connecting linear lesions then completes the left atrial lesions equivalent to the classic Cox maze III operation.

Although this lesion set can be accomplished with any energy source that creates transmural lesion, we have used radiofrequency. The pulmonary vein antra are isolated using three applications of a bipolar radiofrequency clamp (Isolator Synergy Ablation Clamp [Atricure Inc, Cincinnati, OH]) at an average power of 30 watts. The linear lesions are made with a combination of a short (10 sec application of the Atricure Isolator Multifunctional Pen [Atricure, Inc]) and a long (40-sec application) of the Coolrail Linear Pen (Atricure Inc).

Clinical Experience

Intraoperative Electrophysiologic Evaluation

We believe that it is essential to demonstrate activation block across all surgically created lesions. Unlike the

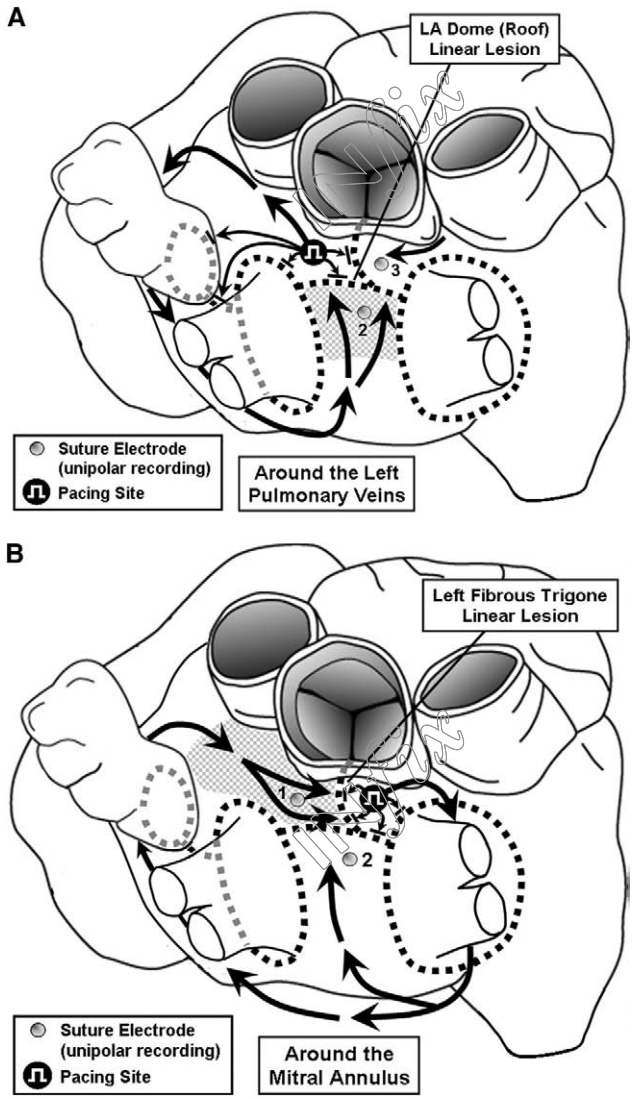

Fig 2. (A) Electrode placement to verify activation block across the transverse dome line. Atrial pacing is initiated anterior to the ablation line at the base of the left atrial appendage (electrode 1) with the activation time to electrode 2 recorded as reference. If activation block is complete, the activation must propagate around the left pulmonary veins (arrows). As a result, activation times measured at several locations in the stippled area will increase as the probe is moved toward the linear lesion. (B) Electrode placement to confirm complete block across the left fibrous trigone line. Pacing is performed on the right side of the trigone line (electrode 3), and activation sequence is determined by recording the activation times to electrode 1 and several sites in the stippled area (using the probe electrode). Activation block is confirmed by measuring increased activation times as the probe is moved medially toward the trigone line along its length. (LA = left atrial.)

cut-and-sew technique, it often requires several epicardial radiofrequency applications to achieve activation block. We routinely apply the radiofrequency energy three times and then test for block. After isolating the PV antra, recordings are obtained along the PVs and the atrium between the isolating lesions and the PVs to demonstrate absence of atrial potentials (entrance block). If isolation has not been achieved, one to two more applications of the bipolar RF clamp are made, and then we retest for block.

Demonstrating block along linear lesions is more difficult and requires determining the activation time at several sites on one side of the lesion line while pacing on the other side (activation sequence). To do this, we place three temporary wire electrodes (one on the left lateral side of the trigone line at the base of the left atrial appendage [electrode 1 in Figs 1 and 2], one on the posterior side of the transverse dome line [electrode 2], and one on the medial side of the trigone line [electrode 3]). Activation block across the transverse dome line can be verified by atrial pacing at the base of the left atrial appendage anterior to the ablation (electrode 1) and measuring the activation time to fixed electrode 2. Then, using a probe electrode to map the posterior left atrium (Fig 2A; gray stippled area) activation times are recorded to show that activation is moving superiorly, toward the dome line (arrows in stippled area). With complete block, activation times will increase as the probe gets closer to the ablation line. Any area toward the lesion showing a decrease in activation time would indicate incomplete block (gap in the lesion).

Confirmation of block across the trigone line can be verified by pacing on the right side of the line (electrode 3) and mapping the region on the left side of the trigone line (Fig 2B; gray stippled area) using the probe electrode, comparing activation times to that recorded to the fixed electrode (electrode 1). Activation should be propagating superiorly and medially toward the trigone line along its length (Fig 2B; arrows in stippled area), indicating no break in the line.

Comment

We have now performed this lesion set using minimal access techniques in more than 50 patients with persistent and longstanding persistent AF. Initially, we used bilateral (6-cm intercostal working) incisions without rib spreading. In the last 10 patients, we performed this lesion set with a totally thorascopic technique using a 5-mm port and two 10-mm ports bilaterally. There has been no mortality or major morbidity. In all of these patients we were able to complete the lesion set and demonstrate complete block across the lesion lines. We are collecting long-erm outcome data to demonstrate efficacy.

Disclosures and Freedom of Investigation

The equipment used in this investigation was purchased and owned by the hospital previously. It was available for use by all the surgeons. The authors had full control of the design of the study and production of the manuscript. No funds were provided for this work.

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Disclaimer

The Society of Thoracic Surgeons, the Southern Thoracic Surgical Association, and *The Annals of Thoracic Surgery* neither endorse nor discourage use of the new technology described in this article.

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