Spot Welding the Gap in Atrial Flutter Ablation

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Figure 1. A, Left anterior oblique view of right atrium (view is from right ventricle looking into right atrium with tricuspid valve removed). Yellow curved arrow demonstrates electrical activation around tricuspid valve annulus during atrial flutter. Isthmus catheter has multiple electrode pairs that record electrical activation and spans isthmus of tissue between inferior vena cava and tricuspid valve annulus. Its poles I-1,2 (I is for isthmus catheter, and 1 and 2 are most distal electrodes) are at coronary sinus ostium, and poles I-19,20 are low lateral right atrium. Intervening poles are numbered sequentially but not labeled. MEA indicates multiple electrode array, part of Ensite 3000 noncontact mapping system, which reconstructs endocardial electrical activation in a 3-dimensional model. Dashed line depicts site of linear ablation for atrial flutter. B, Right anterior oblique view of right atrium. Note that completion of ablation line (dashed line from tricuspid valve to inferior vena cava) will interrupt flutter circuit. Depicted in white is tricuspid valve (which was cut away in Figure 1A). C, Electrograms from intracardiac catheters. Three left complexes show atrial flutter. Note that activation proceeds from poles I-19,20, positioned at low lateral right atrial wall, toward I-1,2, positioned near coronary sinus. This is typical counterclockwise atrial flutter. After third beat during delivery of radiofrequency energy (not shown), atrial flutter terminates and sinus rhythm ensues. Note change in morphology of P waves in lead II. afl and nsr indicate atrial flutter and normal sinus rhythm, respectively.

Figure 2. A, After ablation line is completed, pacing is performed from vicinity of coronary sinus to determine whether line is intact. Note gap in ablation line allowing conduction across isthmus. This is depicted by electrical activation (yellow arrow) proceeding from catheter position I-1,2 directly to I-19,20 through gap. In this situation, there is a high risk of recurrent atrial flutter, because flutter circuit is not fully interrupted. B, Single “movie” frame of a 3-dimensional map generated by Ensite 3000 system. Yellow arrow has been added to show direction of electrical activation during real-time computer display. Area of “pinched” conduction is gap in an ablation line (which permits conduction to “squeeze” through); this critical site is precisely localized by system. This permits ablation catheter to be directly positioned at gap to complete ablation line. MEA indicates multiple electrode array.
Figure 3. A, Pacing from coronary sinus after successful completion of ablation line. Note that electrical activation proceeds from coronary sinus (I-1,2) to point of ablation line, depicted in this figure between electrodes I-7,8 and I-9,10 (not labeled). Because wave front cannot cross barrier (completed ablation line), remainder of isthmus is activated from opposite direction by a wave front that starts at coronary sinus and progresses counterclockwise to low lateral right atrium (I-19,20) and then toward ablation line, where it must stop. It is this presence of a complete line across isthmus of tissue that prevents typical atrial flutter. B, Electrical activation during ablation at site of gap in ablation line. Pacing is occurring from coronary sinus. First 2 complexes (while gap is still present) on left show electrical activation proceeding from coronary sinus region (I-1,2) directly across isthmus to I-19,20 at low lateral right atrium. With third complex, line of ablation is completed and activation can proceed only halfway across isthmus to electrode position I-5,6. Wave front traveling around tricuspid valve annulus in counterclockwise direction activates rest of isthmus from opposite direction. This confirms successful isthmus block with septal pacing. A similar maneuver with lateral pacing is then performed to confirm lateral-to-septal block. MEA indicates multiple electrode array.