

### 1036-84 The "R on T" Phenomenon During Supraventricular Extrasystoles: Fact or Fiction?

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Ventricular extrasystoles falling during the vulnerable period (VUL) of the prior cycle ("R on T" phenomenon) may set the stage for ventricular arrhythmias (VA). Whether this phenomenon can also occur with supraventricular extrasystoles has not been well established. We investigated this in a canine pacing study, during normally conducted beats (NQRS) and beats with right and left bundle branch block (RBBB/LBBB) in 3 groups of 10 dogs. Catheter ablation was used to produce BBB. After sinus node crush, 3 atrial pacing protocols (burst, single premature, short-long-short methods) were used to achieve the shortest R-R intervals at baseline (BASE) and on isoproterenol (ISO). Using intracardiac catheters, 0.8–1.2 W/s shock was delivered 60 ms after the end of T<sub>1</sub> and scanned decrementally until VA was induced, defining the outer zone (OZ) of VUL.

**Results:** The shortest interval between OZ-VUL and R<sub>2</sub> (ms) were:

	NQRS		RBBB		LBBB	
	BASE	ISO	BASE	ISO	BASE	ISO
Burst	47 ± 20	38 ± 26	19 ± 22	7 ± 26	23 ± 28	24 ± 18
Premature	29 ± 19	35 ± 19	-2 ± 19	1 ± 17	7 ± 24	10 ± 21
S-L-S	31 ± 17	38 ± 26	5 ± 20	-9 ± 24	26 ± 30	23 ± 21

R<sub>2</sub> could be advanced within VUL of R<sub>1</sub> in 11 dogs with BBB, but always after the upstroke or peak of T<sub>1</sub>. No VA was induced by the pacing protocols alone.

**Conclusions:** 1. The "R on T" phenomenon could be demonstrated in this experiment but only when BBB was present. This may be due, at least in part, to the lengthening of repolarization during BBB which allows R<sub>2</sub> to fall within the VUL of R<sub>1</sub>. 2. These data may have clinical relevance, particularly when low-energy atrial defibrillation shocks are coupled to the QRS complexes with varying preceding R-R intervals.

### 1037 Radiofrequency Catheter Ablation and Other Therapeutic Approaches to Atrial Fibrillation and Flutter

Wednesday, March 27, 1996, 3:00 p.m.–5:00 p.m.  
Orange County Convention Center, Hall E  
Presentation Hour: 4:00 p.m.–5:00 p.m.

### 1037-1 Successful Radiofrequency Catheter Ablation of Common Atrial Flutter During Sinus Rhythm

Nadir Saoudi, Hervé Poty, Ahmed Abdel Aziz, Mohan Nair, Brice Letac. *Vacomed group, University of Rouen, France*

In patients (Pts) with intermittent atrial flutter (AFI) referred for radiofrequency (RF) catheter ablation (CA) of the inferior vena cava-tricuspid isthmus (IVC-TR), clinical AFI may be difficult to induce, a fibrillation may be the triggered arrhythmia. Because the target is anatomically defined, CA during sinus rhythm (SR) should be possible, but to date criteria for predicting late success are lacking. Based on our previous experience, we tested the ability of RF pulses to create complete bidirectional block (BI) in the IVC-TR isthmus in Pts in whom AFI could not be induced. Evidence of creation of BI was provided by comparing changes in impulse propagation before and after RF delivery when pacing on both sides of CA site. This was assessed by multiple points recordings (mean = 26) at the lateral right atrial wall (LRA), IVC-TR and coronary sinus ostium (CSOs) areas and interatrial septum. CA during SR was performed in 10 Pts (Gr I; 9 males mean aged 59.6) and pursued in SR after RF AFI interruption but without evidence of BI in an additional 14 pts (Gr II; 11 males, mean aged 54.7). **Results:** In all 10 Gr I Pts prior to CA, CSOs pacing resulted in a clockwise wavefront propagating via IVC-TR to LRA, and in a counterclockwise front propagating upwards to the His bundle and the high RA, with resulting mid LRA impulse collision. Inverse observations were made with low LRA pacing. Isthmus BI was demonstrated using pacing techniques showing a wavefront propagating in a single direction from the pacing site, but not anymore crossing the CA site in 5/9 Gr I Pts after 6.8 ± 4.8 RF pulses (2–15) and in 11/14 Gr II Pts after 13.3 ± 10.3 RF pulses (2–24). Detailed IVC-TR mapping showed incomplete BI in 7 Pts with IVC-TR delay, LRA displacement of collision but still IVC-TR impulse crossing during PCS pacing. After a 14 weeks follow-up, recurrences were observed in only 2/24 Pts in whom complete BI could not be obtained. **Conclusion:** Attainment of IVC-TR complete BI as evidenced by careful IVC-TR mapping is feasible during SR.

### 1037-2 Technology and Method for the Creation of Left Atrial Endocardial Linear Lesions to Ablate Atrial Fibrillation

Boaz Avital, Ray W. Helms, Wesley Chiang, Alexey Kotov. *The University of Illinois at Chicago, IL*

Previously we have shown an effective method and technique for the creation of right atrial linear lesions. In this investigation we developed a similar method and technique to create linear lesions in predetermined left atrial (LA) territories for the ablation of atrial fibrillation (Afib). The ablation system consists of a 7F catheter, a guidewire (GW), and a 12F sheath. The catheter has 22 4 mm ring electrodes (spaced 4 mm apart) and a monorail ring at its tip. The GW has a floppy tip with a small bulge proximal to this tip. The sheath is 73 cm long and has a 30° bend at its tip.

**Methods & Results:** In 4 dogs with sustained Afib, a Brockenbrough atrial transeptal system was used to introduce the sheath into the LA. The GW was inserted and positioned within the LV or a left pulmonary vein (PV). The catheter was advanced inside the sheath over the GW into the LA (with the GW feeding through the monorail). By pulling back the GW, the catheter was deflected to form a variety of vertical and horizontal loops of various sizes and shapes within the LA. Positioning was guided via fluoroscopy and transesophageal echocardiography (TEE). Three continuous transmural linear lesions were generated with RF power (20–30 watts) applied through each ring electrode: #1) vertical, from the mitral ring (MR) to the PV's up medially to the LA appendage; #2) vertical, from the MR to the PV's up laterally to the LA appendage; #3) horizontal, in the mid-atrium perpendicular to #1 & #2 under the PV's. Bipolar recording using each of the ring electrodes showed distinct organization in the Afib character as the lesions were generated. Afib became non-inducible after lesion #3. Total lesion application time was 2 hours. **Conclusions:** This system can be used to efficiently create linear transmural LA lesions to ablate Afib. It holds promise for the ablation of Afib in humans.

### 1037-3 Radiofrequency Ablation of the Atrium Using Sequential Coil Electrodes

S. Adam Strickberger, James Davis, Mark A. Maguire. *University of Michigan, Ann Arbor, Michigan; Medtronic Cardiorhythm, San Jose, California*

Radiofrequency (RF) ablation of atrial fibrillation is thought to require multiple long linear lesions. These types of lesions are difficult to generate with 4 mm electrodes. The purpose of this study was to determine the lesion size created with multiple sequential coil electrodes. In 8 dogs, a catheter with four 0.5 cm electrically isolated coil electrodes was positioned in the right or left atrium via the venous system. For left atrial lesions, a transeptal approach was utilized. The RF generator had a maximum output of 50 watts and had a closed loop temperature control system. The target temperature ranged from 70–85°C and the RF energy was applied to each coil individually for 60 sec. Therefore, 4 applications of RF were required to make a full length lesion. 20 full length lesions were generated with a mean lesion volume of 131.6 ± 77.3 mm<sup>3</sup> (depth 1.7 ± 0.9 mm, width 6.2 ± 1.2 mm, length 21.9 ± 3.9 mm). The mean temperature of these applications was 71.9 ± 6.3°C and was achieved with 17.7 ± 10.1 watts. Seventy percent of the lesions were transmural throughout the length of the lesion. There were an additional 10% of lesions in which the lesion was transmural throughout part of the length of the lesion. During these 80 applications of energy (20 full length lesions) 4 were associated with coagulum formation. Coagulum formation never occurred with target temperatures < 85°C. In conclusion, these results demonstrate the feasibility of using multiple sequential coil electrodes to generate long linear transmural atrial lesions. With this closed loop temperature control system, coagulum formation are infrequent and are associated with high (≥ 85°C) target temperatures.

### 1037-4 Results of Linear Right Atrial Radiofrequency Ablation With a Temperature Controlled, Multiple Coil Electrode Catheter

Mark A. Mitchell, Ian D. McRury, David E. Haines. *University of Virginia, Charlottesville, Virginia*

We hypothesized that 1) continuous linear radiofrequency (RF) ablation lesions could be created in the right atrium (RA) and 2) atrial activation mapping could predict successful lesion formation and location.

**Methods:** Six mongrel dogs were anesthetized and a jugular vein, femoral artery and vein were cannulated. RA activation was mapped (unipolar, 1–1000 Hz) during sinus rhythm and RA pacing from 2 sites using a 64 electrode basket mapping catheter (EP Technologies). Sequential temperature-controlled RF lesions were created with an 8 F multiple coil electrode catheter (EPT) to produce a continuous ablation from the superior to the inferior vena cava. RA activation mapping was repeated. Conduction block was defined as > 20 ms delay in > 2 contiguous mapped sites.

**Results:**  $12 \pm 2.2$  RF lesions (range 9-15) were created per dog (mean power  $48 \pm 26$  W). At necropsy, mean ablation area was  $482 \pm 131$  mm<sup>2</sup>. Lesion continuity was seen in 3 of 6 ablations and was associated with fewer RF applications ( $10.3 \pm 1.5$  vs.  $13.6 \pm 1.2$ ;  $p = 0.039$ ), higher mean RF power ( $57 \pm 27$  W vs.  $44 \pm 24$  W;  $p = 0.029$ ) and larger lesion area ( $576 \pm 94$  mm<sup>2</sup> vs.  $389 \pm 88$  mm<sup>2</sup>;  $p = 0.065$ ). Adequate maps were obtained in 5 dogs, and correctly identified conduction block correlating with the anatomic lesion in 4 of 5 dogs.

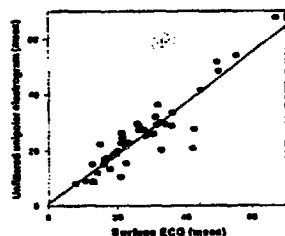
**Conclusions:** Linear RF lesions can be successfully created with a temperature controlled, multiple coil-electrode catheter, but are dependent on optimal catheter position. Unipolar RA activation mapping can identify areas of conduction block which correspond to lesions observed at necropsy.

**1037-5 Onset of the Unfiltered Unipolar Electrogram as an Alternative Reference for Timing Distant Atrial Depolarization**

Venkateshwar K. Gottipaty, Peter L. Friedman, William G. Stevenson. Brigham and Women's Hospital, Boston, MA

**Introduction:** P-wave onset in the surface ECG is commonly used as a timing reference for atrial mapping. P-wave onset is difficult to assess when superimposed on the T-wave, and at rapid recording speeds. Since "unfiltered" unipolar electrograms are heavily weighted by far-field signals the onset of the atrial electrogram in unfiltered unipolar recordings may provide an alternative reference point. **Methods:** In 10 consecutive patients a decapolar catheter (electrode spacing: 5 mm alternating with 2 mm) was positioned in the high right atrium. "Unfiltered" (0.5-500 Hz) bipolar electrograms from all 10 electrodes and a 6 lead surface ECG were recorded simultaneously. For each bipolar electrode pair the time from the peak of the bipolar signal to the earliest onset of P wave in the surface ECG (X-axis), and to the earliest onset of the unfiltered unipolar atrial electrogram (Y-axis) recorded from one of the electrodes of the bipolar pair, were measured. **Results:** The interval from time of local depolarization to either the onset of the P-wave in the surface ECG, or the onset of the unfiltered unipolar atrial electrogram were closely correlated ( $r^2 = 0.9$ ).

Time to bipolar peak from onset of P-wave in:



**Conclusion:** Onset of the "unfiltered" unipolar electrogram, recorded from a single electrode, maybe a useful alternate reference to the surface ECG for timing atrial activation during catheter mapping.

**1037-6 Prevention of Atrial Flutter With Epicardial Artilide**

S. Adam Strickberger, Vinod Labhasetwar, James Davis, Thomas Underwood, Robert J. Levy. University of Michigan, Ann Arbor, Michigan

Atrial arrhythmias after bypass surgery often delay hospital discharge and result in significant morbidity. Controlled release antiarrhythmic drugs can be delivered via coated wires implanted on the epicardial surface. This experiment was conducted to test the hypothesis that epicardial administration of artilide from a controlled release system can decrease the inducibility of atrial flutter (AFI). 11 dogs underwent a thoracotomy. An atrial incision was made horizontally at the inferior border of the atrium along the vena cava. Another incision was made from the initial incision to the right atrial appendage. The incisions were then closed. A pacing catheter was positioned in the right atrial appendage via the right femoral vein. 8 attempts at inducing AFI were made by burst pacing the atrium for three seconds at cycle lengths of 150, 140, 130, 120, 110 and 100 msec. Persistent AFI (5 minutes) was the endpoint of each burst pacing attempt. Sinus rhythm was restored with overdrive pacing. After determining the induction rate (%) of AFI in the baseline state, a wire coated with the drug delivery system, either impregnated with ( $n = 6$ ) or without ( $n = 5$ ; control) 20% artilide, was sewn onto the right atrium between the horizontal incision and the AV groove. After 60 minutes, the induction protocol was repeated. The induction rate of AFI decreased from  $32.2 \pm 10.3\%$  before the artilide wire was applied to the heart, to  $19.0 \pm 11.8\%$  ( $p = 0.02$ ) after the drug wire was applied. In the control dogs, AFI was induced  $29.4 \pm 10.5\%$  at baseline, and  $25.2 \pm 11.9\%$  after implantation

of the control wire ( $p = 0.4$ ). In the coronary sinus, the artilide concentration was  $1.23 \pm 1.48$  ng/ml at the conclusion of the experiment. In conclusion, an implantable controlled drug release system that results in very low systemic artilide concentrations, appears to decrease the inducibility of AFI after experimental atriotomy. These results may suggest that after bypass surgery, atrial arrhythmias may be prevented by artilide used in conjunction with a controlled release system.

**1037-7 Transcatheter Subendocardial Infusion-A Novel Technique for Ablation of Atrial Flutter**

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Radiofrequency catheter ablation of atrial flutter is limited by relatively small lesions, which may not completely eliminate conduction through the posterior right atrial isthmus critical to the maintenance of the tachycardia. The purpose of the current study was to assess the feasibility of transcatheter subendocardial infusion of ethanol for complete ablation of the isthmus.

**Methods:** A 7 FR deflectable lumen electrode catheter was equipped with a #27 needle protruding 2 mm from the tip. An ablation injectate consisting of ethanol, iohexal and glycerin was infused into the target site using a power injector. In 5 closed-chest dogs (weight  $24 \pm 1$  kg), the infusion ablation catheter was applied to the isthmus and two infusions (0.5 cc/5 sec) were delivered. Electrophysiology study was performed before and after ablation. The myocardial stain produced by infusion ablation was recorded by fluoroscopy. Lesion dimensions were measured pathologically.

**Results:** There was no change in sinus cycle length, AH interval, HV interval or AV block cycle length after infusion ablation of the isthmus. There was no change in right atrial pressure or arterial pressure as the result of ablation. Fluoroscopic staining allowed acute assessment of lesion adequacy. Pathologic analysis showed transmural lesions involving the entire isthmus in all 5 animals. Mean lesion dimensions were  $12 \pm 6$  mm  $\times$   $5.5 \pm 3$  mm.

**Conclusions:** Transcatheter ethanol infusion produces transmural lesions that consistently and safely ablate the entire isthmus. Additional studies of this technique for the treatment of atrial flutter seem warranted.

**1038 ICDs - Ventricular Tachycardia**

Wednesday, March 27, 1996, 3:00 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E  
Presentation Hour: 3:00 p.m.-4:00 p.m.

**1038-8 Subpectoral Approach to ICD Implantation: Shoulder Associated Problems in Long-Term Follow-Up**

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In 40 patients (pts) (Age:  $56 \pm 13$  years, male: 34, female: 6) with left- or right-sided subpectoral implantation of a fourth generation implantable cardioverter defibrillator (PCD 7219/7220/7218, volume: 83 cm<sup>3</sup>, weight: 132 g) the ipsilateral shoulder joint was examined regarding decreased motility, insertion tendinitis and morphological alterations during postoperative follow-up. Motility of the shoulder during frontal and transversal motion and rotation, elevation of the shoulder, and pain on pressure and motion typical for insertion tendinitis were documented preoperatively and 3, 6 and 12 months after ICD implantation. An ultrasound and an x-ray of the shoulder were additionally performed preoperatively and after 3 and 12 months. Physiotherapy was always started within 24 hours after implantation.

**Results:** Subpectoral implantation was in 38 pts performed with a left-sided. In 2 pts with a right-sided approach due to previous left-sided operation. The preoperative investigations of the shoulders were normal in all pts. The following pathological findings were made postoperatively:

	3. month	6. month	12. month
Complaints (n):	25 (62%)	25 (62%)	5 (13%)
Decreased abduction (n):	20 (50%)	12 (31%)	5 (13%)
Decreased forward flexion (n):	15 (37%)	10 (25%)	5 (13%)
Decreased rotation (n):	7 (26%)	5 (19%)	3 (10%)
Shoulder elevation (n):	25 (62%)	25 (62%)	5 (13%)
Insertion tendinitis (n):	25 (62%)	25 (62%)	11 (27%)

All postoperatively performed ultrasounds and x-rays showed no morphological alterations of the shoulders.

WEDNESDAY POSTER