Avoiding tachycardia alteration or termination during attempted entrainment mapping of atrial tachycardia related to atrial fibrillation ablation

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BACKGROUND Entrainment can be useful for mapping atrial tachycardias (ATs) after atrial fibrillation (AF) ablation but may result in AT alteration or termination.

OBJECTIVE We aimed to determine the incidence and risk factors for AT alteration or termination.

METHODS In 30 consecutive patients, 62 ATs (mean cycle length [CL] 268 ± 53 ms) in which overdrive pacing for entrainment mapping was performed were retrospectively analyzed. AT was classified as altered if the CL or activation pattern remained altered 10 seconds after pacing. The variability in the PP intervals was determined over 10 beats from 2 measures: (1) the difference between the shortest and the longest CL expressed as a percentage of the CL and (2) the mean difference between sequential PP intervals expressed as a percentage of the AT CL (CLD_{mean}).

RESULTS Of 386 total pacing attempts (tachycardia CL [TCL] – pacing CL [PCL] difference 15 ± 6 ms), 5 (1.3%) altered or terminated AT and 381 did not change AT (98.7%). When the TCL − PCL difference was ≤20 ms, only 2 of 353 (0.5%) attempts altered or terminated AT. When the TCL − PCL difference was >20 ms, 3 of 33 (9%) attempts altered or terminated AT. The difference between the shortest and the longest CL expressed as a percentage of the CL was significantly greater in ATs that were altered or terminated by pacing than in those unchanged (11.0% ± 9.6% vs 4.5% ± 4.5%; $P = .007$), but the mean difference between sequential PP intervals expressed as a percentage of the AT CL was not significantly different (3.8% ± 2.6% vs 1.9% ± 2.1%; $P = .06$).

CONCLUSION Overdrive pacing for entrainment mapping rarely alters or terminates after atrial fibrillation AT, provided that AT is stable before pacing and that the PCL is ≤20 ms shorter than the AT CL.

KEYWORDS Atrial tachycardia; Atrial fibrillation; Mapping; Overdrive pacing; Entrainment; Catheter ablation

ABBREVIATIONS **AF** = atrial fibrillation; **AT** = atrial tachycardia; **CL** = cycle length; $\mathbf{CLD_{max}}$ = difference between the shortest and the longest cycle length expressed as a percentage of the cycle length; $\mathbf{CLD_{mean}}$ = mean difference between sequential PP intervals expressed as a percentage of the atrial tachycardia cycle length; **PCL** = paced cycle length; **TCL** = tachycardia cycle length

(Heart Rhythm 2015;12:32–35)

Introduction

Organized atrial tachycardia (AT) related to catheter ablation of atrial fibrillation (AF) occurs commonly during or after ablation.[1–4] AT may be focal (automaticity or microreentry) or due to macroreentry,[5–7] the differentiation of which is critical for effective ablation. There is not a clear consensus on whether entrainment mapping or activation mapping is the optimal approach for mapping AT related to AF ablation. Overdrive pacing for entrainment is a quick and effective means of characterizing and localizing these ATs; however, alteration or termination of AT may limit its utility. In this retrospective study, we evaluated the results of overdrive pacing of AT related to AF ablation in 30 consecutive patients to determine the risk of alteration or termination of AT.

Dr Kumar is a recipient of the Neil Hamilton Fairley – Overseas Clinical Fellowship cofunded by the National Health and Medical Research Council and the National Heart Foundation of Australia; he is also a recipient of the Bushell Travelling Fellowship funded by the Royal Australasian College of Physicians. Dr Tedrow has received consulting fees/honoraria from Boston Scientific and St Jude Medical and research funding from Biosense Webster and St Jude Medical. Dr John has received consulting fees/honoraria from St Jude Medical. Dr Epstein has received consulting fees/honoraria from Boston Scientific, Medtronic, and Spectranetics. Dr Michaud has received consulting fees/honoraria from Boston Scientific, Medtronic, and St Jude Medical and research funding from Boston Scientific and Biosense Webster.
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1547-5271/$-see front matter http://dx.doi.org/10.1016/j.hrthm.2014.09.002

Methods

Study population

A total of 30 consecutive patients (11 women; mean age 64 ± 10 years) who either presented with or developed a sustained left AT during radiofrequency ablation of AF at a single tertiary care medical center between July 1, 2012, and January 1, 2013, met the following entry criteria and were included:

1. One or more sustained ATs with a consistent biatrial activation pattern and consistent cycle length (CL) > 200 ms before pacing occurred.
2. More than 1 left atrial overdrive pacing attempt was made from a catheter within the coronary sinus or via transseptal approach within the left atrium.
3. During pacing, all atrial electrograms were accelerated to the pacing rate.

Cavotricuspid isthmus–dependent right ATs were excluded. Overdrive pacing was performed using a paced CL (PCL) 5–40 ms below the shortest tachycardia CL (TCL). AT was classified as altered if the CL or activation pattern remained altered 10 seconds after pacing.

Assessment of CL and CL stability

Measurements of AT CL stability were made by an investigator blinded to the result of overdrive pacing. The 10 PP intervals preceding the first overdrive pacing attempt for each AT were measured at a sweep speed of 200 mm/s (Figure 1). The mean of these values were taken as the TCL. PP interval stability was determined by 2 measures:

1. The difference between the shortest and the longest CL expressed as a percentage of the CL (CLD_{max}): [CL_{max} – CL_{min})/AT CL] × 100 (Figure 1).
2. The mean difference between sequential PP intervals expressed as a percentage of the AT CL (CLD_{mean}): (mean CL difference/CL) × 100 (Figure 1).

Electrophysiology study

All patients provided written informed consent. All antiarrhythmic drugs except amiodarone were discontinued a minimum of 5 half-lives before the procedure.

Surface and intracardiac electrocardiograms were digitally recorded and stored (Prucka CardioLab EP system, GE Healthcare, Waukesha, WI). Nonfluoroscopic 3-dimensional mapping was performed using the Carto (Biosense Webster Inc, Diamond Bar, CA) or Ensite NavX (St Jude Medical, St Paul, MN) system at the discretion of experienced operators.

A 7-F multipolar (20-pole) catheter (Daig DuoDeca 2-10-2, St Jude Medical, orISMUS, Biosense Webster) was used with the distal poles (poles 1–10) placed within the coronary sinus and the proximal electrodes (poles 11–20) located along the tricuspid annulus in the lateral and inferior right atrium. For left atrial mapping and recording, a 10- or 20-pole circumferential PV mapping catheter (Optima, Irvine Biomedical, Irvine, CA, or Lasso, Biosense Webster) or a 5-spline mapping catheter with splines in the star configuration and 1-mm electrodes (PentaRay NAV, Biosense Webster) was used.

Ablation was performed with a 3.5-mm open-irrigated tip ablation catheter paired with a 3-dimensional mapping system (NaviStar ThermoCool, Biosense Webster).

Statistical analysis

Continuous variables are expressed as mean ± SD and categorical variables as percentages. Statistical analysis was performed using Prism (version 6.0d, GraphPad Software, Inc, La Jolla, CA). Continuous variables were analyzed using the Student *t* test. Categorical variables were analyzed using the Fisher exact test. A 2-tailed *P* value of <.05 was considered statistically significant.

Data collection and analysis were performed according to protocols approved by the Partners Human Subject Protection Committee.

Results

Patient characteristics

The mean age of the patients was 64 ± 10 years; the mean left ventricular ejection fraction was 54% ± 8%; and 13%

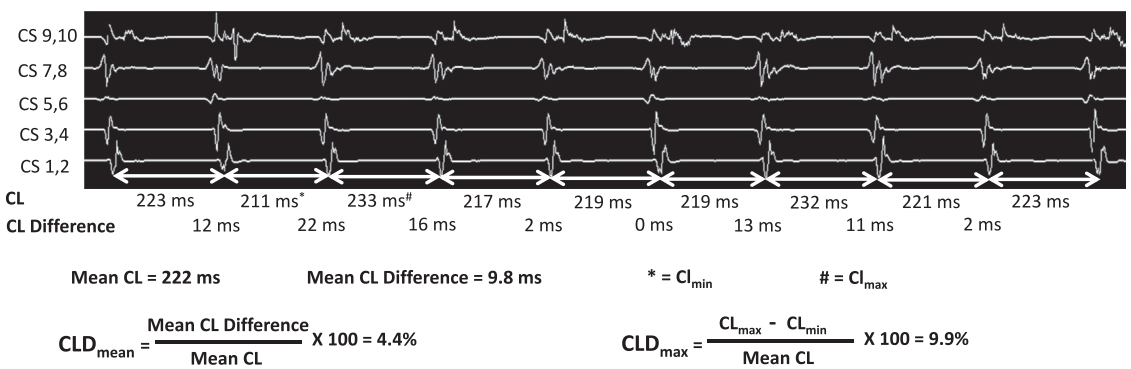

Figure 1 Representative atrial tachycardia intracardiac electrograms. Measured cycle lengths (CLs) over a 10-beat period indicated by white arrows. The mean CL is calculated as the average of measured CLs. The calculated CL differences between consecutive beats are used to calculate the mean CL difference. CLD_{mean} is the mean CL difference as a percentage of the CL. CLD_{max} is the difference between the maximum CL observed (CL_{max}) and the minimum CL observed (CL_{min}) as a percentage of the CL. CS = coronary sinus.