Tachycardia-Induced Cardiomyopathy: Case Presentation and Clinical Management

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DISCLOSURE

- Speaker for AtriCure, Edwards Lifesciences, LivaNova
- Consultant for Medtronic
- Research and educational grants over the last 2 years:
  - AtriCure
  - Edwards
Case Presentation:
History of Present Illness

• 64 yo M engineer, an active marathon runner until he was first diagnosed with atrial fibrillation (AF).

• Presented to hospital on multiple occasions with progressive dyspnea on exertion, decreased endurance and increased palpitation.

• The patient remained in symptomatic AF (+/- RVR) despite trials with several anti-arrhythmic drugs and multiple cardioversions.
Case Presentation:

History of Present Illness

• Three failed attempts at catheter ablation on 2/17/07 (PVI), 6/29/07 (repeat PVI), and on 11/20/07 (repeat PVI, left and right atrial lesions).

• Noted to have progressive worsening LV dysfunction (LVEF: 10-20%).

• Referred to our clinic for surgical ablation.
Case Presentation

Past Medical History:
- GI bleed due to diverticulosis

Home Medication:
- Coumadin, Propafenone, Aspirin, Digoxin, Metoprolol

Physical Exam:
- Vitals - BP: 97/65, HR: 101 irregular, O2 Sat: 96%, BMI: 23.2
- Cardiac exam: tachycardia, irregularly irregular, no murmur
- Otherwise normal exam
Case Presentation:
Preoperative evaluation  - ECG
Case Presentation:
Preoperative evaluation - TTE

• Echocardiogram 4/08/2008 (Patient in Atrial Fibrillation)
  • Four-chamber dilation
  • Severe LV systolic dysfunction, EF 15%
  • Moderate to severe RV systolic dysfunction
  • Normal diastolic function
  • Moderate MR
  • Mild TR
Case Presentation:
Preoperative evaluation - TTE
Case Presentation:

Preoperative evaluation - TTE
Case Presentation:
Preoperative evaluation - TTE post cardioversion

• Echocardiogram 4/15/2008)
  • Upper normal LV size
  • Severe LV dysfunction, **EF 25%**
  • Moderate to severe RV systolic dysfunction
  • **Mild MR**
  • Normal myocardial contractile function and diastolic function by tissue Doppler imaging
Case Presentation:
Preoperative evaluation - TTE post cardioversion
Case Presentation
Preoperative evaluation - Cardiac MRI

- Cardiac MRI 4/15/2008 (Post cardioversion to NSR)
  - Right atrial and ventricular enlargement
  - Left atrium and ventricle appeared normal
  - Global left ventricular hypokinesis
  - Gadolinium enhancement:
    - No evidence of myocardial infarction, fibrosis
Case Presentation
Preoperative evaluation - Cardiac MRI
Case Presentation

Preoperative evaluation - Cardiac Cath

• Cardiac catheterization
  • Right dominant
  • No coronary artery disease
  • Impaired global ejection fraction with normal hemodynamics
  • Normal right-sided pressures
Case Presentation

Preoperative evaluation - Cardiac Cath
Case Presentation

Preoperative evaluation - Cardiac Cath
Case Presentation

Preoperative evaluation - Cardiac Cath
Operative Approach

- Median sternotomy
- Stand alone Cox-Maze IV Procedure
Case Presentation

Postoperative evaluation - TTE

- Echocardiogram 12/28/2015 (NSR) - 7 years later!
  - Normal LV size and systolic function, **EF 67%**
  - Normal LV wall thickness/mass
  - Normal RV size with normal function
  - **Mild MR + TR**
Case Presentation

Postoperative evaluation - TTE
Case Presentation

Postoperative Follow-up

- Office visit 7/18/2017 – 9 years later!
  - Doing well, running regularly (1-6 miles daily), lifting weights regularly

Home Medication:
- Aspirin

Physical Exam:
- Vitals - BP: 113/71, HR: 63 regular
Case Presentation:
Postoperative Holter Rhythm Monitoring

- Annual Holter recordings have shown no recurrent atrial tachyarrhythmias.
- Last Holter 7/18/2017 – NSR - 9 years later!
  - Predominant rhythm: Sinus with average HR of 69
  - 60 episodes of SVT with maximum duration of 11 beats
  - No sustained episodes of AF
What is Tachycardia-Induced Cardiomyopathy?

• Unexplained REVERSIBLE systolic dysfunction AND any form of long-standing tachycardia
• Must exclude secondary causes of cardiomyopathy (e.g., ischemic and dilated cardiomyopathy)
• Definitive diagnosis is ONLY made after cardiac function restoration following rate and/or rhythm control


Tachycardia-induced Cardiomyopathy

Definition

• Sustained heart rate > 100 beats/min
• Exclusion of other causes of heart failure
  • echo, cardiac cath, cardiac MRI
• Partial or complete recovery of LV function after restoration of sinus rhythm
  • preop cardioversion/rate control

Mueller AL, et al.
J Am Coll Cardiol 2017;69:2160-2172
Tachycardia-induced Cardiomyopathy: How To Differentiate From Dilated Cardiomyopathy?

- LVEF ≤ 45% and LVEDD ≤ 61 mm was predictive of TIC with a sensitivity of 100% and a specificity of 71%
- LVEF < 30% and LVEDD ≤ 66 mm was predictive of TIC with a sensitivity of 100% and a specificity of 83%

Jeong et al.
Clin Cardiol 2008;314:172-178
Tachycardia-induced Cardiomyopathy
How To Differentiate From Dilated Cardiomyopathy?

• Endomyocardial biopsy can be useful
  • Less fibrosis
  • Less T cells and microphages
  • Enhanced myocyte size

Mueller AL, et al.
J Am Coll Cardiol 2017;69:2160-2172
The impact of surgical ablation in patients with low ejection fraction, heart failure, and atrial fibrillation

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Abstract

Objective: Surgical ablation procedures that use the Cox-Maze procedure lesion set were shown to be very effective. However, many surgeons are reluctant to perform the procedure, especially in high-risk patients such as those with reduced left ventricular (LV) function. This study explored the potential impact of the Cox-Maze III/IV procedure on patients with low ejection fraction (EF < 40%) and symptoms of heart failure experiencing atrial fibrillation (AF) who present for cardiac surgery. Methods: A prospective study whereby patients with persistent or long-standing persistent AF who had surgical ablation were followed. Echocardiograms (echo) were obtained; patients with preoperative EF < 40% were included. Health-related quality of life (HRQOL-SF-12) and AF symptom severity were obtained at baseline and follow-up. Rhythm was captured by electrocardiogram (EKG) and 24-h Holter. Results: In the past 5 years, 482 patients had surgical ablation (424 full Cox-Maze) of whom 44 patients met the inclusion criteria; however, two patients did not have an available follow-up echo, leaving 42 patients for analysis. Mean age was 61.1 ± 12.9 years, and additive European System for Cardiac Operative Risk Evaluation (EuroSCORE) of 7.5 ± 3.1. There was no inoperative death, there were no strokes or transient ischemic attacks (TIAs) at follow-up, and EF improved from 30 ± 5.0% to 45 ± 13.0% at a mean of 1.5 ± 11.3 months, postoperatively. The return to NSR at time of follow-up echo was 86% (35/40). The physical functioning HRQOL scores improved (37.0 ± 12.3 to 46.8 ± 9.1, p = 0.02) at 12 months. (population norm = 38.1 ± 9.9) with a significant improvement in symptom severity. Kaplan–Meier event-free survival at 24 months was 87% (confidence interval (CI): 80.4–91.6) (events considered were redo valve replacement, ventricular assist device or death). Conclusions: This is a unique study assessing a high-risk group of patients. Surgical ablation in patients with low EF can be performed in a safe and effective way without added operative risk. Given the potential long-term clinical advantages of a successful surgical ablation in patients with low EF and heart failure, we believe that surgical ablation should be considered in such patients when they present to surgery.

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Keywords: Atrial fibrillation; Surgical ablation; Heart failure; Quality of life
Improvement in Ejection Fraction Following a Cox-Maze Procedure

Ad N, et al.
Eur J Cartio-Thorac Surg 2011;40:70-76
Tachycardia Induced Cardiomyopathy: 
The Washington University Experience

• Between January 2002 and January 2017, 34 consecutive patients with tachycardia-induced cardiomyopathy underwent CMP IV

• Mean age was 56 ± 11 years

• Twenty-four patients (70%) had long-standing persistent AF

• The remainder had paroxysmal (7/34, 21%) or persistent (3/34, 9%) AF
Tachycardia Induced Cardiomyopathy: The Washington University Experience

• Preoperative mean ejection fraction was 32% ± 8% (range, 18% - 40%)

• Ejection fraction improved to 55% ± 8% (95% CI [51%, 58%], P<0.001) at a median 22 months

• Of the 11 patients with NYHA class III/IV symptoms, 8 patients were in class I/II at last follow up, P = 0.02
Tachycardia Induced Cardiomyopathy: The Washington University Experience

Left Ventricular Ejection Fraction in Patients Undergoing Cox-Maze Procedure

Preoperative

Postoperative

LVEF (%)

P < 0.001
Tachycardia-induced Cardiomyopathy

Conclusions

• Tachycardia-induced cardiomyopathy is a known complication of AF/flutter.
• The definition of TIC is one of exclusion.
• Cardiac MRI and occasionally myocardial biopsy can be used to help differentiate it from other cardiomyopathies.
• The presence of TIC is a strong indication for interventional therapy in patients who have failed medical management.
• Surgical results have been excellent in this subgroup of patients.
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Left Ventricular Dysfunction in Atrial Fibrillation: Restoration of Sinus Rhythm by the Cox-Maze Procedure Significantly Improves Systolic Function and Functional Status

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Background. Atrial flutter or fibrillation with rapid, uncontrolled ventricular response may lead to left ventricular dysfunction, and conversion to sinus rhythm with control of heart rate can improve left ventricular ejection fraction. Little is known about the effects of the Cox-maze procedure on this form of tachycardia-induced cardiomyopathy.

Methods. Four hundred forty-three patients underwent the Cox-maze procedure from 1993 to 2002. Ninety-nine had atrial flutter or fibrillation without associated valvular or congenital heart disease, and 37 (37%) had decreased left ventricular function (ejection fraction < 0.35 in 11 [severe], ejection fraction 0.36 to 0.45 in 8 [moderate], and ejection fraction of 0.46 to 0.55 in 18 [mild]). Ages of these 37 patients (34 male) ranged from 35 to 74 years (median, 55 years).

Results. Atrial flutter or fibrillation was present for 3 months to 19 years (median, 48 months) preoperatively, and 24 patients (65%) exhibited symptoms of heart failure. Preoperative ejection fraction ranged from 0.25 to 0.55 (median, 0.45). At last follow-up (median, 63 months), the Cox-maze procedure eliminated atrial flutter or fibrillation in all but 1 patient, and the greatest improvement was observed in patients with severe preoperative impairment (0.31 to 0.55; p = 0.01, preoperative versus follow-up), and patients with preoperative chronic atrial flutter or fibrillation (0.43 to 0.55; p < 0.05 preoperative versus follow-up). This improvement was observed immediately postoperatively and was sustained at last follow-up. Further, improvement in left ventricular function correlated with enhancement of functional status.

Conclusions. In some patients, atrial flutter or fibrillation may be the cause rather than the consequence of left ventricular dysfunction. Importantly, systolic function and functional status can be significantly improved with the restoration of sinus rhythm by the Cox-maze procedure.

Stulak JM, et al
Ann Thorac Surg 2006;82:494-501