Cardiac injury after percutaneous catheter ablation for atrial fibrillation

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Received 4 September 2007; accepted after revision 19 November 2007; online publish-ahead-of-print 3 January 2008

Aims Small elevations in troponin T levels have been shown with limited radiofrequency (RF) ablation procedures for supraventricular tachycardia, usually to levels below the threshold for ischaemia or infarction. Left atrial catheter ablation for atrial fibrillation (AF) requires far more RF energy, therefore could be expected to have greater elevation in troponin T. We determined troponin T levels before and after ablation in these patients to evaluate the amount of rise with this ablation.

Methods All patients undergoing pulmonary vein isolation (PVI) from May 2004 to October 2004 had troponin T levels measured 4 h following completion of the procedure. The first 30 patients also had a troponin T level measured 1 h prior to PVI to establish a baseline reference.

Results Sixty patients were studied, with 81.7% males and a mean age of 54.6 ± 9.9 years. No patient had underlying structural heart disease. The baseline troponin T level was normal (<0.01 mg/L) in all 30 patients. Post-procedure troponin T levels were elevated in all 60 patients compared with baseline (P < 0.05), with a mean level of 0.85 mg/L and a range of 0.26–1.57 mg/L after an average RF ablation time of 56 ± 15 min. All levels were above the reference range for diagnosis of acute myocardial infarction (>0.15 mg/L). Troponin T level was not related to the number of RF lesions, RF time, procedure time, or associated external cardioversion.

Conclusions Troponin T elevations occurred in all patients undergoing PVI, to levels at least 20 times the normal concentration, into the range for diagnosis of acute myocardial infarction. Therefore, troponin T would not be specific for ischaemia in the setting of chest pain post-catheter ablation for AF.

KEYWORDS
Atrial fibrillation;
Troponin T;
Radiofrequency ablation;
Myocardial necrosis

Introduction
Radiofrequency (RF) catheter ablation has become a curative invasive technique for supraventricular tachycardia (SVT).1 Percutaneous catheter ablation with RF abolishes the arrhythmia substrate by creating localized myocardial necrosis of several millimeters in diameter in the endocardium.2 Several prospective studies have shown that such induced necrosis by limited RF catheter ablation for SVT (i.e. atrioventricular nodal reentrant tachycardia, atrioventricular reentrant tachycardia, and atrial flutter) lead to small elevations of the highly cardiac-specific biochemical marker, troponin.3-6 Troponin is more sensitive and specific to detect myocardial damage by RF energy than creatinine kinase and its subfraction (CK-MB) and has shown an impact on the cardiovascular prognosis.3,7 Troponin rise is normally observed within 4 h after onset of myocardial necrosis.8

Left atrial ablation procedures for atrial fibrillation (AF) typically involve far more RF energy delivery than ablations for SVT or even atrial flutter. The objective of this study was to determine the extent of troponin rise after percutaneous left atrial catheter ablation for AF. We hypothesized a significant elevation into the typical diagnostic range for diagnosis of acute coronary syndrome or myocardial infarction.

Methods
Study design
All patients undergoing pulmonary vein isolation (PVI) from May 2004 to October 2004 by percutaneous catheter ablation technique with RF energy were enrolled. Demographic and clinical data were collected prior to the procedure.
Ablation procedure

Patients were brought to the electrophysiological laboratory in a fasting, non-sedated state. Three femoral vein sheaths were inserted under local anaesthesia and sedation. A 6F steerable decapolar electrophysiology catheter Livewire™ (St. Jude Medical Inc., St. Paul, MN, USA) was placed into the coronary sinus. After double trans-septal puncture performed by a BRK™ trans-septal needle (St. Jude Medical Inc.), a 5F circular decapolar catheter Supreme Spiral Sc™ (St. Jude Medical Inc., St. Paul, MN, USA), and a 7F non-irrigated 4 mm tip bi-directional ablation catheter RF Conductr™ MC (Medtronic Inc., Minneapolis, MN, USA) were passed trans-septally through two 8F trans-septal guiding introducers Swartz™ SL1™ (St. Jude Medical Inc.). The left atrium was mapped by either Localisa™ (Medtronic Inc.) or Ensite NavX™ (St. Jude Medical Inc.). The ablation consisted in a continuous circumferential line around both ipsilateral pulmonary veins and in a line across the mitral isthmus. Uncommonly, linear ablation across the roof between the two circumferential lines is also performed. The endpoint of the procedure was electrical isolation of all pulmonary veins. Lesions were delivered for 30 s, at 30 W for a target temperature of 58°C. After the procedure, the patients were monitored for at least 5 h and discharged if stable, the same day or the next day.

Troponin measurements

Troponin T levels were measured 4 h following completion of the procedure by the assay of our local laboratory. The first 30 patients also had a troponin T level measured 1 h prior to PVI to establish a baseline reference. The troponin T level of <0.01 μg/L was considered as normal by our laboratory, 0.05–0.15 μg/L suggestive of an acute coronary syndrome, and >0.15 μg/L suggestive of a myocardial infarction.

Statistical analysis

Statistical analysis was performed using JMP 7 (SAS Software, NC, USA). Continuous variables were analysed using Student’s t-test and are expressed as mean ± SD. Linear regression was used to assess the relationship among continuous variables. A P-value of <0.05 was considered significant.

Results

Demographics

During the period from May 2004 to October 2004, 60 consecutive patients presented for PVI procedure and were studied; of which, 49 patients (81.7%) were males and the mean age was 54.6 ± 9.9 years (range between 26 and 72 years). No patient had significant underlying structural heart disease. Fifty-one patients (85%) had paroxysmal AF and 9 patients had persistent AF.

Procedural characteristics

The total procedural time was 195 ± 24 min. The average RF ablation time was 56 ± 15 min. Direct current cardioversion to terminate AF was performed in 12 patients (20%) with a transthoracic biphasic shock of 200 J. One procedure (1.7%) was complicated by a pericardial tamponade requiring percutaneous drainage. No peripheral or cerebral thrombo-embolic events were observed.

Troponin measurements

The baseline troponin T level was measured in the first 30 enrolled patients and was normal (<0.01 μg/L) in all. Post-procedural troponin T levels were significantly elevated in all 60 patients compared with baseline (P < 0.05), with a mean level of 0.85 ± 0.34 μg/L and a range of 0.26–1.57 μg/L. All levels were above the reference range for diagnosis of acute myocardial infarction (≥0.15 μg/L). Troponin T rise was not greater in patients undergoing direct current cardioversion and RF ablation vs. those with RF ablation alone (Table 1), and no difference between gender was observed. Furthermore, the amount of troponin T elevation was not significantly related to the number of RF lesions, RF time (Figure 1), and procedure time. There was no relationship between RF time and troponin T rise ($r^2 = 0.04/P = 0.07$).

Arrhythmia outcome and need for a repeat procedure

At 6-month after initial procedure, 41 patients (68%) had a significant decrease of their symptomatic burden of atrial arrhythmia with a complete success in 31 patients (52%) and a partial success (≥80% improvement) in 10 patients (16%). A repeat procedure for AF and/or atrial tachycardia/flutter was performed in 19 patients (32%). No correlation was observed between the troponin T elevation and the arrhythmia outcome or the need for a repeat procedure.

Discussion

Our study was able to demonstrate a significant rise in troponin T level after RF ablation for AF by wide-area circumferential ablation lines around the ipsilateral pulmonary veins to levels consistent with acute coronary syndrome or acute myocardial infarction.
Several studies showed elevated troponin T or I after RF ablation for SVT.\textsuperscript{3-6,9-15} A correlation between troponin peak and RF delivery duration, number of RF discharges and cumulative RF energy was shown in previous studies.\textsuperscript{2-6,9-15} Different studies also showed higher troponin levels after linear RF lesions vs. focal RF lesions.\textsuperscript{11}

Our study, however, is the first to include patients having undergone RF ablation of the left atrium for AF. This procedure involves the application of greater total RF duration than ablations for SVT or atrial flutter. This increased myocardial damage by RF energy produced higher troponin levels (0.85 ± 0.34 ng/mL) than conventional RF ablation procedure (0.44 ± 0.47 ng/mL).\textsuperscript{16} However, in our study, there was no correlation between troponin level 4h after RF ablation and the number of RF lesions, RF time, procedure time, or associated external cardioversion. One possible explanation was the lack of serial troponin measurements to find peak troponin T levels. Furthermore, another hypothesis is that the high number of RF lesions applied for the ablation of atrial fibrillation exceeded the critical threshold of myocardial necrosis, above which there is rather a plateau in the relationship than a linear correlation between RF lesions and troponin levels. AF with fast ventricular rate response can lead to an increase in troponin, but troponin measurements prior to RF ablation were normal and only a small percentage of our patients had rapid AF. No correlation was seen between troponin T elevation and arrhythmia outcome. The one patient who suffered a pericardial tamponade detected after 30 min of RF ablation had a troponin T level of 0.32 ng/mL, not significantly increased compared with the other patients having no complication. We think that myocardial necrosis as a result of a procedure related thrombo-embolic mechanism is unlikely as in none of the patients changes in the 12-lead electrocardiogram, suggesting ischemia were documented and neither symptomatic cerebral or peripheral embolic events were observed. But we cannot completely rule out such a complication as no cardiac imaging by echocardiography or scintigraphy was performed routinely. In addition to the remote possibility of a coronary embolism, ablation-related occlusion of the left circumflex artery or similar damage to the right coronary artery or its posterior branches may result in a situation where the troponin elevation may have an ischaemic origin. In this patient group who underwent extensive catheter ablation for AF, myocardial ischaemia may be better assessed by measuring serial myoglobin levels which typically return to normal 20–24 h after RF ablation because of a short half-time of metabolization.\textsuperscript{8}

Limitations

One troponin T level was measured 4h after RF ablation and no serial measurements were performed to assess a peak in troponin T levels. This may explain the lack of correlation between the 4h troponin T level and number of RF lesions and RF time. No myoglobin levels were measured concomitantly to directly compare myoglobin and troponin T levels after ablation.

No functional myocardial imaging (echocardiography or scintigraphy) was performed routinely prior to or after the procedure to rule out myocardial necrosis because of embolic mechanism. Most of the patients complain of peri-cardial irritation following extensive RF ablation in the left atrium, but we did not prospectively assess the extent of symptoms and pericardial effusion. Therefore, no correlation between pericardial effusion and troponin T elevation can be provided.

Conclusions

In light of this finding, an elevated troponin level in patients having undergone RF ablation for AF is not specific for myocardial ischaemia or infarction. Many patients complain of chest discomfort after RF ablation procedure in the left atrium for AF. Often this is because of pericardial irritation or inflammation. Therefore, the utility of troponin T after RF ablation in the assessment of chest pain is limited.

Conflict of interest: none declared.

References