Cardiac troponin T does not increase after electrical cardioversion for atrial fibrillation or atrial flutter

K Greaves, T Crake

Abstract

***Objective*—To determine whether cardiac troponin T increases after electrical cardioversion in patients with atrial fibrillation or atrial flutter.**

***Design*—Serum creatine kinase (CK), creatine kinase-MB (CKMB), and cardiac troponin T were measured before, 24 hours, and 48 hours after cardioversion in 15 patients with atrial fibrillation or atrial flutter.**

***Results*—12 of the 15 patients (80%) were successfully cardioverted to sinus rhythm. The median number of shocks was three (range one to six), the median cumulative energy 710 J (50 to 1430 J), and the median peak energy 300 J (50 to 360 J). Total CK increased from a baseline median concentration of 92 (45 to 259) to 1324 (96 to 6660) U/l at 24 hours and 1529 (120 to 4774) U/l at 48 hours after cardioversion. There was a small increase in CKMB but the ratio of CKMB to CK did not increase. There was no increase in cardiac troponin T in any patient.**

***Conclusions*—Following electrical cardioversion of atrial fibrillation or atrial flutter, cardiac troponin T remains unchanged despite a large rise in total CK, indicating that the CK is derived from skeletal muscle and that myocardial injury does not occur. If cardiac troponin T is increased after cardioversion for atrial arrhythmias then other causes of myocardial damage should be sought.**

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Keywords: atrial fibrillation; atrial flutter; cardioversion; troponin T

Department of Cardiology, St Bartholomew's Hospital, West Smithfield, London EC1A 7BE, UK
K Greaves

Department of Cardiology, The North Middlesex Hospital, London N18, UK
T Crake

Correspondence to:
Dr Greaves.

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Direct current cardioversion for the treatment of atrial fibrillation or atrial flutter is associated with an increase in total creatine kinase (CK) and in the creatine kinase-MB isoenzyme (CKMB).[1–5] Skeletal muscle contains both CK and CKMB[1] and its injury at the time of cardioversion may cause the release of these enzymes. Determination of whether myocardial injury has also occurred by measurement of CK and CKMB can therefore be unreliable owing to their simultaneous release from skeletal muscle. The proportion of the total CK represented by CKMB varies between cardiac and skeletal muscle; in the myocardium it represents approximately 15–30% of total CK, whereas in skeletal muscle it represents 0 to 8%.[1 6] In order to increase the specificity of increases in CKMB for detecting myocardial injury, the ratio of the increase in CKMB to total CK can be determined.[1 7] This approach, although useful in the diagnosis of myocardial infarction, is less useful for the diagnosis of myocardial injury after cardioversion as there is a large increase in total CK from skeletal muscle and this may reduce the ratio of CKMB to CK and decrease the sensitivity of CKMB in detecting myocardial injury.

Cardiac troponin T is a myofibrillar regulatory protein specific to the myocardial cells.[1 8] It has been shown to be a very specific and sensitive marker of myocardial injury.[9 10] In patients with myocardial infarction or unstable angina it is a more sensitive marker of myocardial injury than either CK or CKMB.[9–11]

The purpose of this study was to determine whether cardiac troponin T increases after electrical cardioversion in patients with atrial fibrillation or atrial flutter. Changes in cardiac troponin T may help to determine whether myocardial as well as skeletal muscle injury occurs following a rise in total CK after cardioversion.

Methods

Fifteen consecutive patients (median age 66 (range 55 to 75) years; eight female, seven male) who were undergoing elective cardioversion for either atrial fibrillation (12) or atrial flutter (3) were studied. All patients were anticoagulated with warfarin. Patients were excluded if they had suffered myocardial infarction, had unstable angina, or had undergone either coronary artery bypass surgery, coronary angioplasty, or any other surgical procedure within the previous six months. Five patients had structurally normal hearts, six had coronary artery disease, three had hypertension with mild left ventricular hypertrophy, and one had mild mitral regurgitation.

In all patients synchronised cardioversion was performed entirely as clinically indicated under general anaesthesia, using midazolam 5 mg intravenously and etomidate 0.3 mg/kg intravenously. A Hewlett-Packard defibrillator was used in all patients (Hewlett-Packard Co, Camas, Washington, USA). The hand held electrode paddles were initially placed in the antero-apex position for shocks up to a maximum energy of 360 J, and if cardioversion did not occur with that energy the anteroposterior position was used with an energy level of 360 J. An initial shock energy of 50 J was chosen for the patients with atrial flutter and 200 J for the patients with atrial fibrillation. The

number of shocks given was determined by the clinician undertaking the procedure.

Serum cardiac troponin T, CK, and CKMB were measured before and 24 and 48 hours after cardioversion. The proportion of CKMB as a percentage of total CK was calculated.

CK activity was measured using colorimetry by a Hitachi 917 automatic chemical analyser (Boehringer-Mannheim UK, Lewes, E Sussex, UK). The assay temperature was 37C°C, the linearity of the method was 1500 U/l, and the coefficients of variation within a run and between runs were 2.5% and 4.5% respectively. The upper limit of the reference range was 200 U/l.

CKMB activity was determined by an immuno-inhibition assay from Boehringer Mannheim (Mannheim, Germany). The assay temperature was 37°C, the linearity of the method was 4000 IU/l, and the coefficients of variation within a run and between runs were 1.7% and 3.3%, respectively. The upper limit of the reference range was 24 IU/l.

Cardiac troponin T was measured using the Enzymun-Test (ES 700) from Boehringer Mannheim.[12] The assay temperature was 25°C, the linearity of the method was 0–15 μg/l, and the coefficient of variation within a run was 2.8%. Values in the range 0–0.1 μg/l have been found in healthy subjects.

Data are expressed as median (range) unless stated otherwise. The significance of any changes in the concentrations of cardiac troponin T, CK, and CKMB following cardioversion was determined by the Wilcoxon signed rank test. A probability (p) value of < 0.05 was considered significant.

Results

Cardioversion to sinus rhythm was successful in 12 of the 15 patients (80%). Patients received between one and six (median three) shocks. The cumulative energy given to each patient varied between 50 and 1430 J (median 710 J). The peak energy given to each patient varied between 50 and 360 J (median 300 J). One patient received 360 J on one occasion, two received 360 J on two occasions, and four received 360 J on four occasions.

CK increased from a baseline median (range) concentration of 92 (45 to 259) U/l to 1324 (96 to 6660) U/l at 24 hours and 1529 (120 to 4774) U/l at 48 hours after cardioversion (both $p < 0.001$). In two patients the CK remained within the normal range but in the other 13 it increased to at least two times the baseline concentration. There was a small increase in CKMB of 14 (−6 to 92) IU/l at 24 hours and 10 (−8 to 46) IU/l at 48 hours after cardioversion (both $p < 0.02$). Following cardioversion the proportion of CKMB as a percentage of the increase in total CK was 1.68% (0.86% to 3.29%) at 24 hours and 1.67% (1.1% to 5.1%) at 48 hours. Cardiac troponin T did not change in any patient following cardioversion; it remained < 0.1 μg/l in all patients, before and after cardioversion.

Discussion

In this study we have shown that following elective cardioversion for atrial fibrillation or atrial flutter there are no changes in cardiac troponin T despite a large increase in total CK. These data indicate that the CK is released from skeletal muscle and not from the myocardium after cardioversion, and that no or minimal myocardial damage occurs.

Skeletal muscle injury following transthoracic cardioversion is recognised. The large rise in total CK derived from skeletal muscle may obscure that derived from injured myocardium and hence myocardial injury may be missed.[2 4 5] Furthermore, atrial arrhythmias may present acutely in patients with chest pain and cardioversion is often undertaken; subsequent measurement of total CK may be unreliable in determining whether infarction has occurred, especially when there are no electrocardiographic changes. Experimental studies in dogs have shown that cardioversion may be associated with histological evidence of myocardial necrosis, although higher energy levels were used in those studies than are used in clinical practice.[13]

As CK can be liberated from both cardiac and skeletal muscle, attention has turned to the measurement of the CKMB isoenzyme, which is more specific for cardiac muscle.[1] CKMB represents approximately 15–30% of total CK activity in the myocardium.[1 6] However, CKMB is also present in skeletal muscle and in general represents between 0 and 8% of total CK activity, although in certain muscle groups—for example, the back muscles—it may represent up to 30% of total CK activity.[1 6] As CKMB is released from both injured skeletal and cardiac muscle the ratio of the changes in CKMB to CK is more specific (although less sensitive) than the absolute concentration of CKMB for the diagnosis of myocardial injury. For example, in patients presenting with suspected myocardial infarction and raised total CK concentrations, an increase in CKMB to a concentration greater than 3–5% of the increased total CK would be expected to secure the diagnosis of infarction.[1] In patients undergoing cardioversion such a ratio may be less reliable as there is a large release of CK from skeletal muscle which may decrease the ratio obscuring myocardial injury. Although there was a small rise in CKMB following cardioversion in our study group, it exceeded 3% in only one patient. Ehsani *et al* reported increases in CKMB after cardioversion in two of 35 patients,[4] but these increased concentrations were within the borderline range where myocardial injury was possible and the changes could also have been accounted for by skeletal muscle injury. Jakobsson *et al* reported that seven of 30 patients with atrial fibrillation had increases in CKMB after cardioversion[5] but none of these had an increase in the CKMB to CK ratio. Others have reported similar findings.[2] O'Neill *et al* reported that following cardioversion for ventricular arrhythmias several patients had raised CKMB concentrations, at 10–15% of total CK activity, which is consistent with myocardial injury.[14] However,

in this study several of the patients had ventricular tachycardia or ventricular fibrillation with haemodynamic collapse and required prolonged resuscitation. In this situation periods of myocardial ischaemia would have occurred, possibly resulting in myocardial injury and a resultant increase in the CKMB to CK ratio.

Cardiac troponin T is a myofibrillar regulatory protein and is specific to the myocardium.[1 8] It can be differentiated from its isoforms in skeletal muscle by immunological assays.[1 10] Several studies in patients with chest pain have shown that it is a highly specific and sensitive indicator of myocardial injury.[10 11 15] In patients with suspected myocardial infarction and unstable angina it is a more sensitive indicator of myocardial injury than CK or CKMB.[10 11] After myocardial injury cardiac troponin T increases within three to 12 hours and it remains raised for five to 14 days.[1] In our patient group cardiac troponin T did not increase after cardioversion, indicating that despite the large increase in total CK myocardial injury was unlikely to have occurred.

CONCLUSION AND CLINICAL IMPLICATIONS

Following cardioversion of atrial fibrillation or atrial flutter there is no increase in cardiac troponin T, and myocardial injury from cardioversion is therefore highly unlikely. If myocardial infarction is suspected in a patient presenting with atrial fibrillation and who is subsequently cardioverted, then cardiac troponin T should be measured; this will enable differentiation between CK derived predominantly from skeletal muscle and that additionally derived from cardiac muscle.

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