Effect of electrical cardioversion on myocardial cells in patients in intensive care

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For about 30 years electrical cardioversion has been routine for converting arrhythmias.¹ Whether the application of shocks in the usual dosage is safe is still controversial as minimal myocardial cell injury cannot be excluded.² If simultaneous muscle damage occurs the measurement of common cardiac markers, especially creatine kinase and its isoenzyme creatine kinase MB, lacks specificity. We therefore also measured the concentration of cardiac troponin T as this is the most sensitive and specific marker to date.

Patients, methods, and results

Over the past three years in this unit 69 non-selected patients with atrial fibrillation (aged 21-87, mean 63.7 years) underwent elective countershock using a direct current. Serum samples were taken before and 24 hours after cardioversion. The concentrations of cardiac troponin T, total creatine kinase, and creatine kinase MB were measured by enzyme linked immunosorbent assay (Boehringer, Germany) (reference ranges <0.1 µg/l, 10-80 U/l, and <12 U/l, <6% respectively). A total of 153 shocks was delivered, amounting to an average cumulative energy of 286 J per patient. Cardioversion was started with 50 J of stored energy, and subsequent shocks comprised 100, 200, 300, and 360 J. The procedure was terminated after restoration of sinus rhythm or after two attempts of 360 J each.

Four patients received the highest amount of cumulative energy (1370 J). Sixty seven patients converted to sinus rhythm, and no major complications occurred. At follow up 24 hours later 60 patients had restored sinus rhythm. All measurements of cardiac troponin T activity before and after cardioversion were below 0.1 µg/l. The baseline concentrations and peak activities of creatine kinase and creatine kinase MB were within the normal range except in three cases. In one patient the peak activity of total creatine kinase increased from 13 to 103 U/l but that of creatine kinase MB was normal. In the other two patients the peak activity of creatine kinase was increased from 32 to 363 U/l and from 18 to 512 U/l and that of creatine kinase MB by 33 U/l and by 42 U/l respectively.

Comment

Experiments in animals have shown that necrosis of myocardial cells occurs after repeated countershocks using direct currents of high energy.³ Evidence that electrical cardioversion may result in myocardial damage in humans is based on the increased concentrations of various cardiac enzymes measured after cardioversion.⁴

To overcome the problem of insufficient specificity of cardiac enzymes we measured the activity of cardiac troponin T. Cardiac troponin T is not detectable in the serum of healthy people and can be differentiated from its isoforms in skeletal muscle by immunological techniques; its cross reactivity to mixed skeletal muscle is 1-2%, and its specificity is 95% in the presence of skeletal damage.⁵ Currently, cardiac troponin T is the best marker for detecting minimal myocardial damage, especially when skeletal muscles are also injured.

In our non-selected patient population countershock using direct current was highly effective and without major complications. As we did not find any increase in plasma activity of cardiac troponin T we conclude that myocardial cell injury by electrical cardioversion is unlikely when applying cumulative energies of up to 1370 J. As two patients had raised concentrations of total creatine kinase and creatine kinase MB but not of cardiac troponin T, we conclude that these enzymes originated from injured skeletal muscle. We therefore suggest that the increased concentrations of creatine kinase and creatine kinase MB reported previously in cases of myocardial damage could also have originated from injured skeletal muscle.

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Endpiece

Who's out there?

Communication today has four characteristics; it is global, permanent, immediate, and immaterial. Previously only God had these qualities.

Ignatio Ramonet (of *Le Monde Diplomatique*) quoted in *UNESCO Sources*, April 1997

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