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Original article

Impact of internal and external electrical cardioversion on cardiac specific enzymes and inflammation in patients with atrial fibrillation and heart failure

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ABSTRACT

Background: Implantable cardioverter/defibrillator (ICD) shocks can cause myocardial injury, contributing to the progression of the underlying heart disease. The aim was to evaluate whether internal electrical cardioversion (int-CV) via the ICD or conventional external CV (ext-CV) of persistent atrial fibrillation (AF) in heart failure (HF) patients induces myocardial injury and initiates inflammation.
Methods and results: A total of 115 HF patients with an ejection fraction between 20% and 45% were prospectively enrolled. Fifty-one patients were excluded due to failure of electrical CV at the first attempt as well as early relapse of AF within 8 h after CV. The int-CV group consisted of 22 and the ext-CV group of 42 patients. Baseline values of high sensitive troponin T (hsTnT), interleukin (IL)-6, and C-reactive protein (CRP) did not differ significantly in both groups, whereas baseline N-terminal pro B-type natriuretic peptide (NT-pro BNP) was significantly lower in the ext-CV group. Eight hours after CV, the level of hsTnT increased significantly in the int-CV group, whereas no significant change was observed in the ext-CV group. Furthermore, CV significantly increased IL-6 and CRP in the int-CV group, whereas an insignificant increase could be documented in the ext-CV group. Due to electrical CV in both groups, the NT-pro BNP levels significantly declined in approximately the same content (int-CV 29% vs. ext-CV 36%).
Conclusions: The significant increase in hsTnT, IL-6, and CRP in patients who underwent int-CV compared to those undergoing ext-CV may suggest that int-CV causes significant myocardial damage and induces systemic inflammation.

Introduction

Implantable cardioverter defibrillators (ICDs) have become the standard approach for the prevention of sudden cardiac death (SCD) in patients with heart failure (HF). There is rising evidence that appropriate and inappropriate ICD shocks are associated with an increased mortality in ICD patients [1,2]. The mechanisms for the increased mortality are poorly understood and still need to be elucidated.

Atrial fibrillation (AF) is the most common cardiac arrhythmia in clinical practice with an increasing prevalence and incidence with age and cardiovascular morbidity, such as hypertension, coronary heart disease, and HF [3]. Up to 33% of patients with HF and ICD sustain episodes of AF, which not only can be symptomatic, but also can worsen the HF and cause inappropriate ICD discharges [3], which in turn can negatively affect the mortality [2]. Episodes of persistent AF in patients with ICD device can be electrically cardioverted by synchronized internal or external shock from the ICD or an external defibrillator, respectively. Recently, it could be demonstrated that internal cardioversion (CV) with ICD device is an effective and safe method to restore sinus rhythm (SR) in HF

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patients with AF [4]. However, whether internal CV of AF with an electrical shock by the ICD device also negatively impacts the mortality of ICD patients is unclear. Furthermore, comparative data about the influence of the external and internal electrical CV of AF on cardiac specific enzymes and systematic inflammation are not available. We therefore conducted a prospective controlled pilot study to investigate the impact of internal or external CV on cardiac specific enzymes and inflammation parameters in patients with persistent AF and HF.

Methods

Patients

Potentially eligible patients were prospectively identified in the Electrophysiology Outpatient Department of the Otto-von-Guericke University Hospital Magdeburg. To be eligible, patients had to meet the following requirements: symptomatic persistent AF; absence of acute or subacute myocarditis, a history of myocardial infarction or coronary artery disease, advanced symptomatic HF classified as New York Heart Association class IV, cardiac procedures, such as coronary angioplasty, heart surgery, and catheter ablation in the past 4 months; normal renal, liver and thyroid function, and normal electrolyte balance. We enrolled only patients, in whom rhythm control therapy was pursued. The decision for electrical rhythm management was based on the patients' preference after written informed consent, and defined in accordance with the official AF guidelines [3]. In each study participant, left ventricular ejection fraction (EF) and the size of the left atrium were measured using two-dimensional echocardiography. The enrollment of the patients was not randomized because the patients chosen for external CV did not have ICDs. Only patients with a left ventricular EF between 20% and 45% were enrolled in the study. For the internal CV group we only assigned patients with dual coil and left-side implanted ICDs.

Electrical cardioversion

The electrical CV was performed after appropriate anticoagulation or excluding blood clots by transesophageal echocardiography. In patients receiving external electrical CV, direct current was applied with 200 J as biphasic shock using self-adhesive pads in the anterior-posterior position in accordance with official AF guidelines [17]. In ICD patients, the internal electrical CV was performed with one 21 J biphasic shock. Patients with failed electrical CV at the first attempt as well as with early relapse of AF within the next 8 h after CV were excluded from the study. The same sedation protocol using etomidate and midazolam was deployed in all patients.

High-sensitivity troponin T, interleukin 6, C-reactive protein, and N-terminal pro B-type natriuretic peptide measurements

Venous blood samples were taken from patients and collected in standard serum tubes. Laboratory tests of high-sensitivity troponin T (hs-TnT), interleukin (IL)-6, C-reactive protein (CRP), and N-terminal pro B-type natriuretic peptide (NT-pro BNP) were performed immediately prior to and 8 h after the CV in a central laboratory using standard techniques as described previously [5,6].

Statistical analyses

Numerical data are given as mean ± standard error of mean (SEM) unless otherwise mentioned. The independent sample *t*-tests were used to compare the baseline characteristics between both CV groups. Differences between the laboratory parameters and CV groups were evaluated with repeated-measures ANOVA. Values of $p < 0.05$ were considered as significant. Statistical analyses were performed with the IBM SPSS Statistics 20 software for Windows (Chicago, IL, USA).

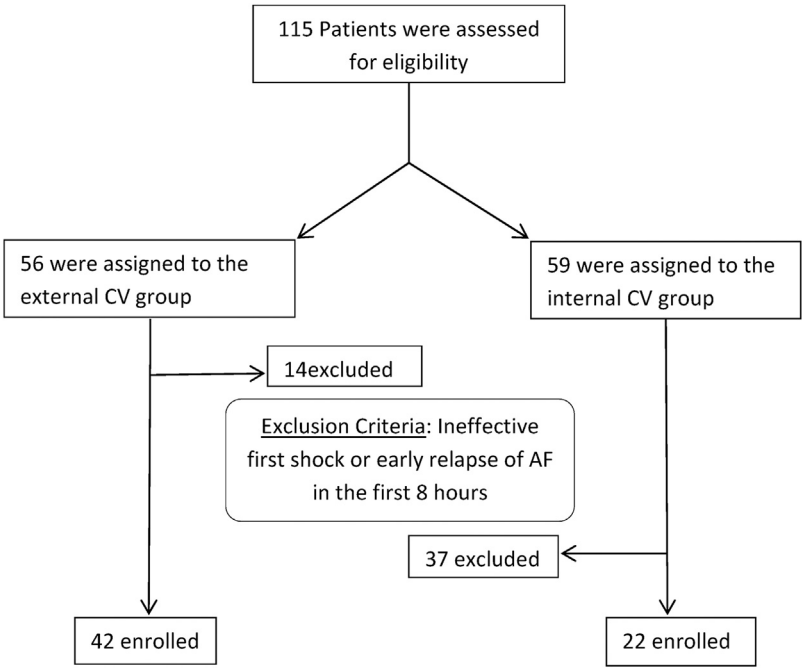

Fig. 1. Flow chart illustrating the study enrollment. A total of 115 patients were initially assessed for eligibility. Fifty-one patients were excluded due to failure of the first applied electrical shock as well as with an early relapse of AF within the first 8 h after CV. Eventually, 64 patients were assigned, of whom 22 were included in the internal CV group and 42 in the external CV group. AF, atrial fibrillation; CV, cardioversion.

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