

Organization Analysis of Atrial Fibrillation Applied to the Improvement of Electrical Cardioversion Protocols

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The development of non-invasive tools able to provide valuable information about the effectiveness of a shock in external electrical cardioversion (ECV) is clinically relevant to enhance these protocols in the treatment of atrial fibrillation (AF). The present contribution analyzes the ability of a non-linear regularity index, such as sample entropy (SampEn), to follow-up noninvasively AF organization under successive attempts of ECV and to predict the effectiveness of every single shock.

To this respect, the atrial activity (AA) preceding each delivered shock was extracted by using a QRST cancellation method. Next, the main atrial wave (MAW), which can be considered as the fundamental waveform associated to the AA, was obtained by applying a selective filtering centered on the dominant atrial frequency (DAF). Finally, the MAW organization was estimated with SampEn and two thresholds ($Th1=0.1223$ and $Th2=0.0832$) were established to predict the ECV outcome.

Results indicated that, prior to the first attempt, all the patients who only needed one shock to restore normal sinus rhythm (NSR) were below $Th1$. In addition, most of them were above $Th2$ in case of AF relapsing during the first month. Regarding several shocks, all the patients who maintained NSR more than one month were below $Th2$ after the first shock. Moreover, all the patients who relapsed to AF during the first month were between $Th1$ and $Th2$ and, finally, all the patients with ineffective ECV were above $Th1$. After each unsuccessful shock, a SampEn relative decrease was observed for the patients who finally reverted to NSR, but the largest variation took place after the first attempt, thus indicating that this shock plays the most important role in the procedure. Indeed, by considering jointly the patients who needed only one shock and the patients who needed several shocks, 91.67% (22 out of 24) of ECVs resulting in NSR, 93.55% (29 out of 31) of ECVs relapsing to AF during the first month and 100% (10 out of 10) of ECVs in which NSR was not restored were correctly classified. As conclusion, the MAW organization analysis via SampEn could provide useful information that could improve the effectiveness of conventional external ECV protocols used in AF treatment.