Internal atrial cardioversion in atrial fibrillation

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Electrical cardioversion is usually performed using the transthoracic technique with delivery of monophasic shocks at 200-360 J and the efficacy results are 61-94%[1,2]. However as little as 4% of the current from an external shock effectively penetrates cardiac tissue, while the majority follows other pathways through the chest[3].

Low-energy internal atrial cardioversion is a relatively new procedure for restoring sinus rhythm in different forms of atrial fibrillation (AF).

Internal atrial cardioversion was initially performed on patients who were resistant to external cardioversion[4]. This procedure can be performed by delivering biphasic shocks between transvenous catheters positioned within the cardiac chambers or great vessels (usually between catheters positioned in the right atrium and coronary sinus or between catheters positioned in the right atrium and left pulmonary artery). Delivery of shocks results in effective cardioversion at energies < 6-10 J and the procedure can be effective even when external cardioversion has failed[4]. Independent of the lead configuration, the efficacy for terminating AF is very high, 92-100% for spontaneous episodes of paroxysmal AF and 70-100% for chronic persistent AF, with relatively low-energy requirements, especially when dealing with paroxysmal AF[2,4-8].

Atrial defibrillation threshold is usually evaluated in clinical studies by adopting a step up protocol[9-13] and this implies some approximation in comparison with the methodology used for defibrillation threshold evaluation in animal studies. Besides clinical issues (type of AF, AF duration, etc.), atrial defibrillation threshold is also dependent upon electrode design and materials[14], electrode size[9], electrode coil length[10], electrode position and shock configuration[6,11-13]. Moreover, atrial defibrillation threshold is lower when biphasic versus monophasic shock waveforms are delivered[15], when asymmetrical waveforms with the second phase shorter than the first phase are used[15-17], and when sequential shocks are delivered through dual current pathways[18].

Patient tolerability to shock delivery is variable and may be influenced by psychological status, patient conditioning, number of shocks delivered, energy delivered, shock waveform, and lead positioning[5,8,16,19-23]. Shock-induced discomfort varies from patient to patient, but the procedure can be usually performed without general anesthesia under mild sedation if necessary. Nevertheless, tolerability has to be improved by obtaining substantial reduction in defibrillating thresholds.

We reported the feasibility of the procedure with no or mild sedation in a substantial proportion of patients[8,24]. Improved tolerance was observed using rounded biphasic waveforms[25], asymmetrical waveforms[17], and higher capacitance waveforms[16]. In addition, pharmacological interventions which reduce defibrillation thresholds may also reduce patient discomfort[13,26]. In clinical practice, the lowest number of shocks to restore sinus rhythm is preferable[27].

The safety issue was obviously investigated because delivery of shocks for defibrillating the atria implies a potential risk of inducing ventricular fibrillation. In order to minimize the risk of inducing ventricular tachyarrhythmias, shock delivery must be synchronous to the QRS and should be avoided during rapid RR cycles (< 300 ms)[28].

The risk of AF recurrence following internal cardioversion is related to atrial remodeling of electrophysiological properties and is particularly high in the first days after restoration to sinus rhythm, and appropriate pharmacological prevention of AF recurrence is required[29].

Although at present time transvenous low-energy cardioversion is still an investigational procedure, a broadening of its indications is expected in the near future. Indications for transvenous low-energy internal cardioversion for AF may be classified as follows:

accepted indications: AF with clinical indications for restoring sinus rhythm with failure of external cardioversion, AF occurring during electrophysiological study;

potential indications: AF in obese patients, AF in patients in whom avoidance of general anesthesia is indicated (elderly patients, patients with respiratory insufficiency, low cardiac output, and chronic obstructive pulmonary disease), AF in patients who refuse general anesthesia, AF in patients in whom sinus node dysfunction or sick sinus syndrome is highly suspected;

possible future indications: AF occurring in intensive care units, AF occurring post-cardiac surgery.

The cost of the procedure, which remains invasive and requires a brief hospital stay, must be balanced with the benefit of restoring sinus rhythm and the possibility of maintaining sinus rhythm in the medium-long term.

Experimental and clinical investigations of low-energy internal cardioversion have resulted in the development of devices for atrial defibrillation (implantable atrial defibrillators or dual defibrillators) whose clinical role and cost-benefit ratio is currently under evaluation[19,20].

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