Editorial comment
Low energy transvenous atrial defibrillation. When and how to use it

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Atrial fibrillation (AF) is the most common sustained arrhythmia in clinical practice, and is associated with significant morbidity and mortality[1].

Conversion to sinus rhythm represents the ideal end-point of therapy for patients with persistent, non-self terminating AF because it should restore normal hemodynamic function, ameliorate symptoms and functional capacity, and most likely, improve survival. Furthermore, recent evidence suggests that AF may cause electrophysiologic changes of the atrial myocardium (defined as atrial electrical remodeling) that favor the perpetuation of AF[2]. Therefore, prompt termination of AF is desirable before these changes take place and become irreversible.

The traditional approach using external direct current cardioversion has an established role in terminating the arrhythmia. Although its overall success is reported to be high, this technique may fail in a number of patients. Among the factors likely to affect the acute results, transthoracic impedance, energy level and paddle position have been implicated[3,4]. In addition, long-term success rate is not ideal, with only approximately one quarter of patients remaining in sinus rhythm if no additional therapy is used[5].

Recently, several investigators have documented successful termination of AF with low energy internal cardioversion after failure of external defibrillation[6,7]. This treatment was initially performed in animal models and was later successfully extended to human beings. Because of improvements in catheter technology, internal cardioversion can now easily be performed by delivering synchronized low energy (3 J) biphasic waveform shocks through temporary transvenous electrodes, one placed in the right atrium and the other either in the coronary sinus or the left pulmonary artery.

Low energy internal cardioversion may have a number of potential clinical applications (Table I). It represents a valuable option in patients with failed external cardioversion, and may be particularly useful in patients with increased transthoracic impedance, such as obese subjects and those with disorders like asthma and emphysema, in whom the success rate of external cardioversion is limited[3,4]. The procedure does not require general anesthesia, and only mild sedation is needed. It may have a higher success rate in long-standing AF compared with external defibrillation[6,7]. It may be used during electrophysiology procedures requiring repeated cardioversion for multiple spontaneous or pacing-induced AF episodes, or in the intensive care unit setting for patients with repeated AF episodes, particularly after open heart surgery[8]. Limitations of the procedure are listed in table II. In particular, it should be noted that low energy internal cardioversion is not to be considered an alternative to external defibrillation, because: 1) the catheterization procedure implies some risks; and 2) considering the similar acute success rate in patients without specific indications to internal cardioversion and the difference in cost between the two procedures (diagnostic-related group reimbursement for external cardioversion is about 1300 vs 5700 Euro for internal cardioversion), cost-benefit reasons favor the use of external cardioversion.

The study by Zardo et al.[9] published in the current issue of the Journal provides further data on the safety, feasibility and patient

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Table I. Clinical applications of internal atrial defibrillation.

Patients resistant to pharmacologic and external direct current cardioversion
Patients with contraindications to general anesthesia
Patients with long-standing atrial fibrillation (greater likelihood of success than external cardioversion)
Patients with multiple atrial fibrillation episodes (e.g., after open heart surgery) in the intensive care unit
During electrophysiology procedures
Patients requiring repeated cardioversion for spontaneous or induced atrial fibrillation episodes
Acute testing of the efficacy of implantable ventricular defibrillator that is programmable for atrial defibrillation

Table II. Limitations of internal atrial defibrillation.

Similar atrial fibrillation recurrence rate as external cardioversion
Cost 4 times higher than external cardioversion
Potential risks associated with cardiac catheterization, offset by lack of need for general anesthesia and related risks
In some patients, coronary sinus not accessible from the femoral route, requiring additional access (internal jugular, antecubital or subclavian veins), which increases the risk of vascular complications and patient discomfort

tolerance of the procedure. In a series of 41 patients with persistent AF lasting for at least 1 month, successful conversion to sinus rhythm was achieved in 100%, with a procedure-related complication rate of only 2% (1 patient developed femoral artero-venous fistula) and no clinical episodes of thromboembolism during 1 month of follow-up. The latter is an important aspect, because restoration of effective atrial mechanical function, which minimizes the patient s risk of embolic events due to intra-atrial thrombi, often lags behind restoration of electrical sinus rhythm[10]. Initial functional impairment of the atrial chambers (atrial stunning) has been reported after internal cardioversion[11]. These findings emphasize the importance of maintaining adequate anticoagulation for 4 to 8 weeks after performing cardioversion[12], as was appropriately done in the study by Zardo et al[9].

The study also provided evidence that the procedure can be performed quite rapidly, as it required only 40 min on average using a single femoral venous approach. This approach, however, is not feasible in some patients, because with currently available catheter designs the coronary sinus is not always accessible from the femoral route, requiring additional access (internal jugular, antecubital or subclavian veins), with subsequent increase in the risk of vascular complications and patient discomfort.

The main component for patients tolerance of the procedure is related to the pain provoked by shocks. Indeed, internal atrial defibrillation was initially considered a method that would diminish the need for sedation by decreasing the shock intensity required for successful cardioversion. In Zardo s study intravenous diazepam was administered before the procedure, and no patient complained of severe chest pain after 2.3 – 1.3 shocks with an energy of about 10 J for both lead configurations tested (i.e., right atrium-coronary sinus and right atrium-left pulmonary artery). It has been suggested that the number of shocks substantially affects discomfort and that 2 to 3 shocks are usually tolerated[13]. The requests for sedation before delivery of the first shock could be decreased by psychologically preparing the patient and, when necessary, using anxiolytic drugs. In addition, lowering the defibrillation threshold by drugs (such as propafenone in Zardo s study) may also reduce the discomfort caused by individual shocks. As immediate reinitiation of AF is a frequent cause for the delivery of additional shocks and, consequently, for the use of sedation, successful pharmacologic prevention of immediate AF reinitiation could further decrease the need for sedation and improve overall acceptance of the therapy.

Low energy atrial defibrillation and implantable devices

An important implication of the study by Zardo et al.[9] pertains to the use of low energy cardioversion with the implantable atrial defibrillator system. The so-called atrioverter has been under systematic use for many years, in animals first, then in humans[14,15]. The device has been shown to have high success rates in patients with either paroxysmal or persistent AF. The shock is synchronized to ventricular activation, so that it is not delivered during the T wave of the preceding QRS complex. Because cardioversion of AF is not an emergency, the device can wait for an RR interval that is long enough (> 300 ms) to permit the shock to be delivered safely[8]. One pitfall of the atrioverter is the fact that the atrial defibrillation threshold tends to increase with time. Another major problem is the tolerance of low energy defibrillator shocks by the patients. Although the shock is tolerable without anesthesia, in our experience, it is associated with significant discomfort. In addition, when the device is programmed in automatic mode and AF is sensed, shocks are delivered at a preset time (for example, 10 a.m. and 10 p.m.). This mode was considered invalidating by most of the patients implanted at our Institution, who chose to have the device reprogrammed in manual mode and the arrhythmia converted in the hospital setting. Therefore, in our experience the atrioverter does not represent a valuable therapeutic option.

An attractive application of low energy internal cardioversion is its use in conjunction with implanted ventricular devices[16]. In the ventricular implantable cardioverter defibrillator (ICD), AF is often responsible for inappropriate shocks. The latter may even be responsi-

ble for ventricular proarrhythmia. Therefore, proper detection and termination of AF with low energy shocks may be a useful addition to currently available ICDs in patients with malignant ventricular arrhythmias and coexistent AF, who represent 5 to 20% of patients requiring ventricular ICDs.

How to maintain sinus rhythm?

Recently, several investigators have focused their efforts on developing new approaches for restoring sinus rhythm in patients with chronic AF. However, for most patients, the major problem is to prevent the recurrence of AF rather than to restore sinus rhythm. The vast majority of patients who undergo cardioversion for long-standing AF require antiarrhythmic agents for maintenance of sinus rhythm. Studies have shown that the likelihood of staying in sinus rhythm at the end of 1 year of treatment with most antiarrhythmic drugs is about 50%[17]. In agreement with these data, AF recurrence rate was 56% at 1 month in Zardo s experience, in spite of prophylactic drug treatment. In addition to this disappointing efficiency rate, antiarrhythmic agents can be relatively expensive, inconvenient to take up to several times a day, and cause a variety of side effects, including ventricular proarrhythmia.

The explosion in methods for restoring sinus rhythm such as low energy internal cardioversion has been accompanied by the development and evolution of curative non-pharmacologic therapies. These include the so-called maze surgical procedure, using extensive atrial incisions to compartmentalize the atrial mass below that critical for perpetuating the arrhythmia[18]. More recent additions include linear atrial radiofrequency ablation replicating the maze operation[19], and ablation of atrial ectopic foci triggering AF[20].

Given the high success rate of these strategies in maintaining sinus rhythm even in patients with resistant AF, one may envision that the combined use of curative procedures and defibrillation techniques could greatly expand the proportion of patients in whom maintenance of sinus rhythm is feasible.

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