Performance of a New Single-Pass Catheter for Intracardiac Cardioversion of Atrial Fibrillation

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Summary

The intracardiac cardioversion of atrial fibrillation has established itself as an alternative after failed external atrial defibrillation. Standard cardioversion catheter is equipped with two shock coils: the distal coil is inserted into the coronary venous system and the proximal coil is placed within the right atrium. For R-wave-synchronized shock delivery, it is often necessary to introduce an additional ventricular lead into the heart. This study compared clinical performance of a new single-pass catheter, equipped with four rings for R-wave detection from the coronary venous system and a flexible distal end, to the performance of a conventional VascoStim TC 2+2 CK catheter. Fifteen men and three women (mean age 53 ± 9 years) with incessant atrial fibrillation participated in the study. Previously, 3 ± 2 external shocks at 360 J had failed to terminate the arrhythmia. Each catheter was evaluated in nine patients and was successful in 88.8 % of them. To detect ventricular signal, an additional ventricular lead had to be inserted in one patient from the single-pass catheter group (11.1 %) and in five patients from the VascoStim group (55.6 %). Mean shock energy for cardioversion was 9 ± 5.5 J (single-pass) and 12 ± 5 J (VascoStim). The cardioversion was successful after 3 ± 1.5 shocks in the single-pass and after 2 ± 1.3 shocks in the VascoStim catheters. The fluoroscopy times was 7 ± 2.4 min (single-pass), compared to 8 ± 5.9 min (VascoStim). In conclusion, the flexible distal end of the single-pass catheter allowed easier positioning of the lead and reduced fluoroscopy time. This feature together with the availability of four diagnostic rings at the catheter tip rendered R-wave-triggered shocks possible in 88.9 % of the patients without insertion of an additional ventricular lead.

Key Words

Intracardiac cardioversion, R-wave synchronization, single-pass catheter

Introduction

Intracardiac cardioversion of atrial fibrillation is used after external atrial defibrillation has failed to terminate atrial arrhythmia and during electrophysiological studies. With regard to positioning and the number of catheters used, several different solutions have been proposed in the literature [1-5]. The configuration with one shock coil placed in the distal coronary sinus and the other in the right atrium has been shown to be the most effective in arrhythmia termination and associated with the lowest cardioversion energy [4]. Hence, standard cardioversion catheters are equipped with two shock coils and are inserted into the coronary sinus. To ensure R-wave-synchronous shock delivery, usually an additional lead or catheter has to be placed in the right ventricle [5]. This study evaluated a new single-pass catheter (Biotronik, Germany) designed to improve sensing of the ventricular signal via the catheter itself. This catheter is expected to allow reliable R-wave-triggered cardioversion without insertion of an additional ventricular lead.

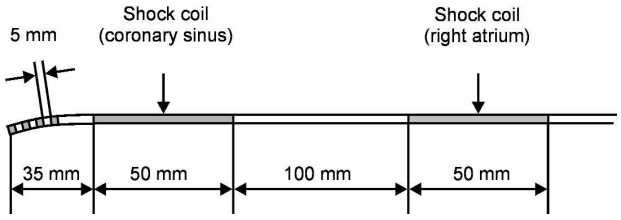

Figure 1. Design of the novel single-pass catheter for internal atrial cardioversion (Biotronik, Germany).

Materials and Methods

Design of the studied novel single-pass catheter is illustrated in Figure 1. The 35-mm-long distal part of the lead is made of a flexible material, in order to facilitate coronary sinus access and the advancement and positioning of the catheter in the coronary system. This segment also contains four rings for improved detection of the ventricular signal necessary for R-wave-triggered cardioversion. The cardioversion is effected via two shock coils – one in the right atrium and one in the coronary sinus. The shock is delivered with the aid of an implantable cardioverter-defibrillator (ICD) programmer (TMS 1000, Biotronik).

Fifteen men and three women (mean age 53 ± 9 years) participated in the study. The patients had persistent (n = 16), permanent (n = 1), and paroxysmal (n = 1) atrial fibrillation. Previously, 3 ± 2 external atrial defibrillation shocks at 360 J had failed to terminate the arrhythmia.

Clinical performance of the single-pass catheter was compared to that of the standard VascoStim TC 2+2 CK catheter (VascoMed, Germany). The latter is equipped with two distal rings for sensing ventricular activity and has a less flexible catheter tip. The systems were used in alternation, resulting in nine patients being treated with the single-pass and nine with the VascoStim catheter.

The catheters were introduced through the superior vena cava into the right atrium and then advanced into a side-branch of the coronary sinus. The ventricular signals were measured using sensing electrodes situated at the catheter tip (Figure 2). To compare handling characteristics of the catheters, total examination time and fluoroscopy time were recorded. Also, the number and energy of cardioversion shocks were notified during the entire study.

Results

In either single-pass or VascoStim catheter group, intracardiac cardioversion was successful in eight out of nine patients. With the VascoStim catheter, an additional ventricular lead had to be inserted in five patients (55.6 %) due to unreliable ventricular sensing. In the single-pass catheter group, this was the case in only one patient (11.1 %). The study duration was similar for both groups: 30 ± 10 min (single-pass) versus 29.0 ± 15.5 min (VascoStim). The fluoroscopy time did not differ significantly between the two groups, with the tendency for shorter times to occur in single-pass catheters (7.0 ± 2.4 versus 8.0 ± 5.9 min, respectively). Table 1 illustrates the number of delivered shocks before successful conversion of atrial arrhythmia, the mean energy of successful shocks, and the measured right atrial diameter. In the single-pass catheter group, the mean cardioversion energy was by 3 J lower than in the VascoStim group, despite notably larger atrial size.

Discussion

Intracardiac cardioversion is a very promising therapeutic option in patients with persistent atrial fibrillation [1-5]. Reliable detection of R-wave is crucial for the safe application of the cardioversion shock, which must take place during the absolute refractory period in the ventricle [3]. The requirement for reliable ventric-

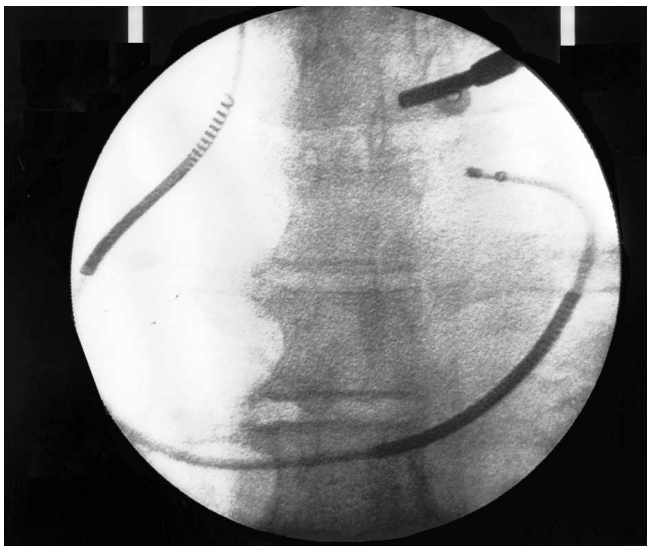

Figure 2. Final position of the single-pass catheter inserted into the coronary venous system (example of first design in one patient).

	Examination (min)	Screening (X-rax; min)	Right atrial diameter (mm)	No. of shocks	Shock energy (J)	R-wave amplitude (mV)
Vascostim	29 ± 15.5	8.0 ± 5.9	51 ± 6.8	2 ± 1.3	12 ± 5	3 ± 1.5
Single-pass catheter	30 ± 10	7.0 ± 2.4	60 ± 3.7	3 ± 1.5	9 ± 5.5	3 ± 0.9

Table 1. Comparison of measured values in the standard VascoStim TC 2+2 CK catheter (VascoMed, Germany) and the single-pass catheter (Biotronik, Germany).

ular sensing necessitates placement of the cardioversion catheter far enough into the peripheral coronary venous system and as proximally to the left ventricle as possible. In contrast to the VascoStim catheter, the novel single-pass catheter allowed reliable R-wave detection in the vast majority of patients. The obtained improvement is ascribed to the more flexible distal end of the catheter equipped with a greater number of sensing electrodes at its tip.

There were only slight differences between study duration and fluoroscopy times for the two groups. This indicates that positioning of an additional ventricular lead along with conventional cardioversion catheters takes a similar amount of time to that needed to advance the single-pass lead into coronary venous system periphery. The latter solution, however, facilitates termination of atrial fibrillation, as two shock coils surround the left atrium. Threshold energy of conversion shocks was thus reduced in the single-pass catheter in spite of the larger atria in this patient. The reason for greater number of shocks delivered in the single-pass group was that conversion energy in this group was incremented in smaller steps than in the VascoStim group.

Conclusion

The results demonstrate the feasibility of intracardiac cardioversion of atrial fibrillation using only one catheter. The more flexible distal end of the Biotronik single-pass catheter results in excellent handling characteristics and allows positioning of the catheter tip deeply into the coronary venous system. Moreover, the availability of four sensing rings ensure a reliable R-wave-triggered cardioversion shock delivery. The achieved mean cardioversion energy is comparable to the values seen in the literature. With the single-pass catheter, the stress imposed to the patient during the procedure is reduced to a minimum.

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