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Cryoablation for treatment of cardiac arrhythmias: results of the European Heart Rhythm Association survey

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The purpose of this survey was to assess the current practice in Europe regarding cryoablation for treatment of different cardiac arrhythmias. The data are based on an electronic questionnaire sent to members of the European Heart Rhythm Association Research Network. Responses were received from 49 centres in 18 countries. The results show that cryoablation for supraventricular tachycardia in European centres is an alternative to radiofrequency ablation, which is in accordance with guidelines. There is reasonable consensus regarding clinical results and complications of cryoablation procedure. Some inter-centre variability with respect to patient selection and ablation strategy in cryoablation of atrial fibrillation was demonstrated, underscoring the need for further research.

Keywords Cryoballoon • Catheter ablation • Supraventricular tachycardia • Atrial fibrillation • EHRA survey • EP wire

Introduction

Cryoablation is a relatively new technique for catheter ablation. It has been widely employed to treat various cardiac arrhythmias. Cryoenergy is considered to be safe in catheter ablation of arrhythmias—appropriate control of freezing temperature can render myocardial lesion reversible. As such, this method has been suggested as an alternative to radiofrequency ablation in order to minimize injury to the atrioventricular node during ablation of para-Hisian arrhythmias.[1–3] Since the development of cryoballoon technique, cryoablation has attracted increasing attention as a treatment method for atrial fibrillation (AF).[4,5] Both cryoenergy and radiofrequency energy are recommended for pulmonary vein isolation in AF patients.[6,7] Although the number of cryoablation procedures is constantly growing, many clinical issues are still unclear. Randomized controlled data regarding the procedural details are limited and there may be considerable variability between operators and centres.[8–10]

The aim of this survey was to provide an insight into the current practice in Europe regarding the cryoablation therapy for different cardiac arrhythmias and to identify the issues which may need further investigations.

Methods

The survey is based on an electronic questionnaire sent out to the members of the European Heart Rhythm Association (EHRA) Research Network. Responses were received from 52 centres in 18 countries, and 49 completed the entire survey and were qualified for further analysis. Percentages are expressed with the denominator indicating the number of centres that provided responses to each question.

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Table 1 Use of cryoablation for treatment of supraventricular tachycardia and ventricular tachycardia

	WPW (atrioventricular reentrant tachycardia)	Atrioventricular nodal reentrant tachycardia	Ectopic atrial tachycardia	Atrial flutter	Ventricular tachycardia
Routinely (>80%)	0 (0)	3 (6.1)	0 (0)	0 (0)	0 (0)
In majority of cases (50–80%)	1 (2.0)	1 (2.0)	0 (0)	0 (0)	0 (0)
In minority of cases (20–50%)	1 (2.0)	3 (6.1)	0 (0)	1 (2.0)	0 (0)
In selected cases (<20%)	29 (59.2)	19 (38.8)	12 (24.5)	5 (10.2)	4 (8.2)
Never	19 (38.8)	23 (46.9)	37 (75.5)	43 (87.8)	45 (91.8)

Number (percentage) of centres is presented.
WPW, Wolff–Parkinson–White syndrome.

Table 2 Acute success, recurrence and procedure-related complication rates of SVT with cryoablation compared to radiofrequency ablation, as indicated by responding centres

	Acute success	Long-term recurrence rate	Procedure-related complication rate
Higher	1 (2.0)	21 (42.9)	0 (0)
Lower	12 (24.5)	6 (12.2)	14 (28.6)
Similar	19 (38.8)	5 (10.2)	16 (32.6)
I have no data	3 (6.1)	3 (6.1)	5 (10.2)
I do not perform cryoablation for SVT	14 (28.6)	14 (28.6)	14 (28.6)

Number (percentage) of centres is presented.
SVT, supraventricular tachycardia.

Results

Of 49 centres that completed the survey, 41 (83.7%) were university hospitals, 4 (8.2%) non-university public hospitals, 3 (6.1%) private hospitals, and 1 (2.0%) other type hospital. Five centres (10.2%) each performed ≥1000 catheter ablation procedures for all types of arrhythmias during the last calendar year, 13 (26.5%) performed 500–999 procedures, 16 (32.7%) 300–499 procedures, 5 (10.2%) 200–399 procedures, 7 (14.3%) 100–199 procedures, and 3 (6.1%) centres performed 50–99 procedures. Cryoablation was available in all participating centres. The total number of cryoablations during last calendar year was 300–500 procedures in 3 (6.1%) centres, 200–299 in 4 (8.2%), 100–199 in 8 (16.3%), 50–99 in 21 (42.9%), and <50 procedures in 21 (42.9%) centres.

Cryoablation for treatment of supraventricular tachycardia and ventricular tachycardia

The rate of cryoablation use for various supraventricular tachycardias (SVT) and ventricular tachycardias (VT) is shown in *Table 1*. Cryoenergy was routinely used only in few centres (6.1%) for ablation of atrioventricular nodal re-entry tachycardia, whereas most of centres restricted its use to selected cases only, or to minority of patients (2–6%, depending on arrhythmia type). Cryoablation was rarely used for VT ablation—only 8% of centres used this technique in selected cases. The main reason for choosing cryoablation rather than other energy sources for the treatment of SVT was safety (69.4%) followed by other facts in a rather small proportion: simplicity (8.2%), high procedural success rate (2.0%), and low recurrence rate during long-term follow-up (2.0%). No centre considered shorter procedure duration and lower costs as an advantage of cryoablation. Meanwhile, the reasons discouraging from using cryoablation for SVT included: high recurrence rate during long-term follow-up (55.1%), long procedure duration (36.7%), costs and reimbursement issues (20.4%), low procedural success rates (18.4%), and difficulties performing the procedure (12.2%). Safety issues were not considered a reason for not using cryoenergy by any centre. Notably, 14 (28.6%) centres have never used cryoablation for SVT treatment. Empirical data for acute success, recurrence and procedure-related complication rates of SVT ablation with cryoenergy are demonstrated in *Table 2*.

Cryoablation for treatment of atrial fibrillation

Cryoablation was used for treatment of AF in 44/49 (89.8%) centres. The rate of cryoablation use for AF based on centre volume is shown in *Table 3*. The reasons for choosing cryoablation for the treatment of AF rather than other energy sources were reported as follows: simplicity of the procedure (81.6%), short procedure duration (73.5%), safety (44.9%), high procedural success rate (26.5%), and low recurrence rate during long-term follow-up (20.4%). On the contrary, reported reasons discouraging from using cryoablation for AF included: variances in anatomy of pulmonary veins (40.8%), insufficient data on success rates in all types of AF (24.5%), costs and reimbursement issues (20.4%), and to a small extend safety issues (4.1%), and low procedural success rate (2.0%). Difficulties in performing procedure, long procedure duration, and high recurrence rate during long-term follow-up were not considered as obstacles by any responder. Remarkably, other issues raised by the responders, as hindering the use of cryoablation, included high radiation exposure (12.7%), concomitant atrial flutter (6.2%) and repeat ablation procedure (2.0%). On the other hand, 17 (34.7%) centres stated that they routinely performed cryoablation procedure for AF without any problem.

Table 3 Use of cryoablation for atrial fibrillation in centres with different ablation volume

Centre volume	Low volume (50–199/year) $n = 11$	Medium volume (200–499/year) $n = 20$	High volume (>500/year) $n = 18$	Total $n = 49$
Routinely (>80%)	3	6	4	13 (26.5)
In majority of cases (50–80%)	1	1	4	6 (12.3)
In minority of cases (20–50%)	2	5	8	15 (30.6)
In selected cases (<20%)	1	7	2	10 (20.4)
Never	3	2	0	5 (10.2)

Number (percentage) of centres is presented.

Table 4 Complications of atrial fibrillation with cryoablation compared to radiofrequency ablation, as indicated by responding centres

	Pericardial effusion/tamponade	Phrenic nerve palsy	Pulmonary vein stenosis	Cerebral stroke/TIA	Groin bleeding/ haematoma	Atrio-oesophageal fistula
Similar	16 (36.4)	6 (13.6)	10 (22.7)	19 (43.2)	29 (65.9)	4 (9.1)
Lower	20 (45.5)	2 (4.5)	15 (34.1)	10 (22.7)	2 (4.5)	9 (20.5)
Higher	2 (4.5)	31 (70.5)	0 (0)	1 (2.3)	6 (13.6)	0 (0)
I have no data	6 (13.6)	5 (11.4)	19 (43.2)	14 (31.8)	7 (15.9)	31 (70.4)

Number (percentage) of centres is presented. TIA, transient ischaemic attack.

Table 5 Recurrence rates of atrial fibrillation with cryoablation compared to radiofrequency ablation, as indicated by responding centres

	Early recurrence (within 3 months)	Mid-term recurrence (3–12 months)	Late recurrence (>12 months)
Similar	22 (50.0)	26 (59.1)	26 (59.1)
Lower	15 (34.1)	11 (25.0)	9 (20.5)
Higher	2 (4.5)	1 (2.3)	0 (0)
I have no data	5 (11.4)	6 (13.6)	9 (20.5)

Number (percentage) of centres is presented.

Among 44 centres performing cryoablation for AF patients, 15 (34.1%) performed cryoablation only in patients with paroxysmal AF, 23 (52.3%) in patients with paroxysmal and persistent AF, while cryo-balloon technique was used for all paroxysmal, persistent and long-standing persistent AF in 6 (13.6%) centres. Concomitant atrial flutter and long-standing persistent AF were not regarded as an indication for AF cryoablation in 28 (63.6%) and 35 (79.5%) centres, respectively.

With respect to practical details during procedure, cryoenergy application settings for pulmonary vein isolation varied substantially among different centres. Application duration of 3 min was used by 22.7% of responders, 4-min applications were used by 43.2% of centres. In 31.8% of centres, decision on application duration was made based on time-to-effect (time from start of cryoablation to disappearance of the pulmonary vein potentials) and in 2.3% of the centres it was related to balloon generation. The 'no bonus freezing' strategy was used by 38.6% of centres if the pulmonary vein was isolated after the first energy delivery, one extra freezing cycle was used by 25.0% and the number of cryoenergy applications depended on time-to-effect in 36.4% of centres.

Several techniques have been used to monitor function of the phrenic nerve during cryoenergy application within right-sided pulmonary veins, including abdominal palpation or visual inspection of diaphragmatic contraction during phrenic nerve pacing in 41 (93.2%) centres, monitoring of the diaphragmatic compound motor action potential in 11 (25.0%), intermittent inspection of fluoroscopy to assess diaphragm movement during phrenic nerve pacing in 11 (25.0%) and venous pressure measurement from the large vein in subdiaphragmatic region (e.g. femoral vein, inferior caval vein) in 2 (4.5%). No centre reported lack of phrenic nerve function monitoring during cryoenergy application.

The empirical data on ablation-related complications and recurrence rates of AF during follow-up are demonstrated in *Tables 4 and 5*.

Discussion

Cryoenergy has been widely used for catheter ablation of various types of SVT for years and has been extended to AF ablation only recently.[1–5] This EP wire survey increases our understanding of variability of cryoablation application among European centres.

Cryoenergy has been proved safe for catheter ablation of SVT, especially for those associated with high risk of atrioventricular block.[1–3] The results of this survey have shown that cryoablation was

often used for ablation of Wolff-Parkinson-White syndrome and atrioventricular nodal re-entrant tachycardia, in selected cases (such as para-Hisian arrhythmias, children and young patients) in most of participant centres. This indicates that cryoenergy is still an alternative to radiofrequency ablation, which is accordant with recommendations of the scientific societies.[1,2] It is obvious that cryoenergy is seldom used in ablation of atrial flutter and VT, probably because radiofrequency ablation is more efficient and without high risk of atrioventricular block in these cases. Although the results with cryoablation are recognized similar, or at least not inferior, to radiofrequency ablation for SVT, a number of centres have never employed cryoenergy in SVT ablation. Possible causes for this include an anticipated high recurrence rate during long-term follow-up, long procedure duration, and issues of costs and reimbursement, as has been highlighted by our results.

The number and proportion of AF ablation procedures have greatly increased in the last years,[5] but the complexity of the procedure is challenging and clinical results of AF ablation are not yet optimal. The cryoballoon technique may offer an alternative in order to simplify the procedure, increase the reproducibility, and improve clinical outcome of AF ablation. The results of this survey show that cryoballoon technique has been widely used in European centres, yet with great discrepancy. The number of cryoballoon procedures for AF varies independently on ablation volume of centres (*Table* 3). The majority of responding centres perform AF cryoablation only in minority of cases or in selected patients.

The most frequently reported advantages of cryoballoon use in AF ablation include simple and short procedure, high procedural success and lower recurrence rates during long-term follow-up and safety. However, shortcomings that may obstruct the application of this technique highlighted by many centres include variant pulmonary vein anatomy, insufficient data on success rates in all types of AF, concomitant atrial flutter, high radiation exposure and issues of costs and reimbursement. This indicates that experience with cryoballoon ablation of AF is possibly based on treatment of selected patients in most of centres. We have observed a great variability in patient selection/exclusion, ablation protocol and assessment strategy.

Most of studies on cryoablation of AF are single-centre reports,[11,12] and only a few multiple-centre trials have been published.[8,10,13,14] Furthermore, no study on cryoballoon ablation for long-standing persistent AF is available.[15] Whether the cryoballoon technique may benefit the patients who undergo repeat procedures is still unknown. It is obvious that clinical investigations are demanded. Our results also point out that the majority of the responding centres have some consensus that recurrence and complication rates are similar or lower (except for the phrenic nerve injury) with cryoablation compared with radiofrequency ablation. Although several studies have investigated these techniques,[8,10,13,16] the knowledge is still limited mainly to paroxysmal AF and experience in clinical practice is not fully revealed.[17] This is further supported by the fact that several centres addressed no data on these issues available from their centres, especially on long-term outcomes and specific complications, such as pulmonary vein stenosis, cerebral stroke and atrio-oesophageal fistula. Therefore, more randomized, multiple-centre clinical trials with long-term follow-up may provide the data and clarify these questions.

Conclusions

This EP wire shows that cryoablation for SVT in European centres is an alternative to radiofrequency ablation in selected cases, which is in accordance with guidelines. There is a reasonable consensus regarding clinical results and complications of cryoablation. Some variability in cryoballoon ablation of AF is demonstrated among centres with respect to patient selection and ablation strategy which needs for further studies.

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