Cryoballoon pulmonary vein ablation and left atrial appendage closure combined procedure: A long-term follow-up analysis

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BACKGROUND The combined left atrial appendage closure (LAAC) and cryoenergy pulmonary vein isolation (PVI) procedure has been proven safe and effective in managing stroke in patients with nonvalvular atrial fibrillation (AF), although most data refer to procedures performed using radiofrequency as the main energy source.

OBJECTIVE The purpose of this study was to evaluate long-term follow-up of patients with AF undergoing concomitant LAAC and cryoenergy PVI.

METHODS Patients undergoing LAAC and cryoballoon PVI at our institution were enrolled. At 3, 6, and 24 months from the index procedure, we determined the atrial arrhythmia recurrence rate, the extent of LAAC, and the rate of cerebrovascular/bleeding events.

RESULTS Forty-nine patients (mean age 69 ± 8 years; 67% men; CHA_2DS_2-VASc score 2.8 ± 1.2; HAS-BLED score 3 ± 1) with a guideline LAAC indication were included. Acute PVI and complete LAAC were achieved in 100% of patients. All patients completed at least 24 months of follow-up. At 8 weeks and 6 months, complete or satisfactory (<5 mm leak) LAAC rates were achieved in 82% and 18% and in 86% and 14% of patients, respectively. The overall freedom from atrial arrhythmia rate at 24 months was 60%, and 92% of patients were off antithrombotic drugs. The observed annualized stroke and bleeding rates were 1% and 2%, respectively, a 71% and 60% risk reduction in comparison to event rates predicted from CHA_2DS_2-VASc and HAS-BLED scores.

CONCLUSION Concomitant cryoballoon ablation and LAAC procedures appear safe and effective at long-term follow-up, with high antithrombotic drug withdrawal rates at 24 months.

KEYWORDS Atrial fibrillation ablation; Combined procedure; Cryoballoon; Intracardiac echocardiography; Left atrial appendage closure

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Introduction

Percutaneous left atrial appendage closure (LAAC) is currently used as a stroke prevention option in patients with atrial fibrillation (AF) and vitamin K antagonist (VKA) or non–vitamin K oral antagonist (NOAC) intolerance.[1–6] LAAC is usually performed as a stand-alone procedure; however, the feasibility, safety, and effectiveness of LAAC alongside concomitant AF catheter ablation (combined procedure) have been described.

Furthermore, combined procedure studies have reported outcomes at short-, mid-, and longer-term follow-up,[2–6] comparable to the stand-alone LAAC with a later AF catheter ablation procedure (staged strategy), with the main advantage of bringing the patient into the operating room once.[2,11]

Recent studies of combined procedures have been almost exclusively focused on irrigated/nonirrigated radiofrequency catheter ablation with regard to the AF ablation procedure.[2,9] To date, longer-term data on the combined procedure with cryoballoon ablation procedures are lacking, with only a single study from our group describing a smaller cohort with mid-term follow-up.[3]

In this study, we report the long-term outcome of combined LAAC and cryoballoon catheter ablation procedures performed in a single center over a 7-year time frame.

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Methods

Study population

In this survey, we enrolled patients undergoing a combined cryoballoon ablation and LAAC procedure at our institution from January 2010 to January 2017, with at least 24 months of follow-up. The combined procedure represented the first catheter ablation procedure in all cases; no combined procedure as a redo of a previous AF ablation procedure was enrolled.

LAAC indication was set because of a high bleeding risk/previous major bleeding event in antithrombotic therapy or because of a previous ischemic event despite antithrombotic therapy; our center's LAAC indications complied with the Munich consensus document since its publication in 2016.[1] Patients with either paroxysmal, persistent, or long-standing persistent AF were included. The study was approved by both scientific and ethical review boards at our institution and complies with the Declaration of Helsinki. Patients gave informed consent, and data were retrieved from a central de-identified database.

Procedural planning

Within 7 days before the procedure, all patients underwent transesophageal echocardiography (TEE) or a contrast cardiac computed tomography scan to rule out left atrial appendage (LAA) thrombi and to assess LAA anatomy. The combined procedure was performed with uninterrupted antithrombotic regimen according to current clinical practice. All procedures were performed by experienced operators (with >50 cryoballoons and >20 LAAC procedures per year).[10] Moreover, all physicians involved were a part of a dedicated team to minimize the learning curve effect within the study.

Cryoballoon ablation

The arrhythmia ablative protocol comprised a pulmonary vein isolation (PVI) procedure through cryoenergy. Cryoablation procedures were performed as previously described[3] in accordance with the 2017 expert consensus.[11] In brief, a single transseptal puncture was performed under fluoroscopy and/or intracardiac echocardiography (ICE, Abbott, XXXX, CA) guidance. A 28-mm second-generation cryoballoon (Arctic Front Advance, Medtronic, XXXX, MN) was inserted through a steerable sheath (FlexCath, Medtronic) in the left atrium (LA). Notably, in the first 9 cases, the first-generation cryoballoon (Arctic Front, Medtronic) was used because the second-generation cryoballoon was not commercially available in Europe. During right-sided pulmonary vein (PV) cryoablation procedures, phrenic nerve pacing was conducted to monitor nerve function and diaphragmatic response; cryoablation procedures were terminated at the first sign of diminished diaphragmatic response. PVI was confirmed by positioning the Achieve mapping catheter to the ostium most proximal site. By conventional pacing maneuver, complete bidirectional block along the PV-LA junction was assessed.

LAAC

In conjunction with ICE and fluoroscopy guidance, LAAC procedures were performed under 2- or 3-dimensional ultrasound guidance. All LAAC procedures were performed as previously described.[3] In brief, a Watchman device (Boston Scientific, MA) or the Amplatzer Cardiac Plug (Abbott, CA) was used to occlude the LAA. When using ICE, the probe was moved into the LA by crossing the atrial septum alongside the first transseptal puncture and was then placed in front of the LAA for direct visualization. A 10%–25% upsizing in device dimension was routinely performed to promote effective compression for device stability. Before device release, the following procedural criteria had to be met: (1) <3 mm residual lateral flow, (2) absence of mitral valve interference, (3) correct device position in relation to the circumflex artery plane, and (4) confirmed device stability by a tug test.

Acute procedural outcomes

Acute catheter ablation success, LAA occlusion, and periprocedural adverse events were assessed during all procedures. *Periprocedural adverse events* were defined as follows: (1) serious pericardial effusions requiring drainage, (2) acute device embolization (<24 hours) assessed by TEE and fluoroscopy, (3) procedure-related transient ischemic attack (TIA)/stroke, and (4) vascular adverse events (major bleeding, groin hematoma, pseudoaneurysm, and arteriovenous fistula).

Patient postprocedural management and follow-up

All patients (excluding inherited bleeding disorders that received only low-molecular-weight heparin [LMWH]) were discharged on LAAC device guideline-recommended antithrombotic regimen, specifically aspirin + warfarin/NOAC/LMWH following Watchman occlusion or VKA/NOAC/LMWH or aspirin and clopidogrel in case of absolute contraindication to anticoagulants following Amplatzer occlusion. These regimens were maintained for at least 2 months.

Eight-week follow-up TEE was recommended to assess device placement and residual leakages. Device positioning was denoted as "satisfactory" if peridevice flow was <5 mm and as "optimal" if no peridevice flow was detectable[12]; second TEE was repeated at 6 months. Patient follow-up visits were scheduled at 6, 12, and every 12 months thereafter. Atrial arrhythmia recurrence was assessed at all visits by symptom reporting, baseline electrocardiography, and 24-hour Holter monitoring electrocardiography.

Given satisfactory LAA occlusion at 8 weeks, antithrombotic therapy was de-escalated. Specifically, Watchman de-escalation called for a switch to dual antiplatelet therapy (75 mg clopidogrel plus 100 mg aspirin) for 6 months and then lifelong 100 mg aspirin; the Amplatzer de-escalation protocol instead called for a 100 mg aspirin regimen for at least 3 months.

Long-term outcome analyses

For the LAAC efficacy analysis, data on the occurrence of TIA/stroke or systemic embolism were collected. In addition, all bleeding events were considered according to the

Bleeding Academic Research Consortium criteria.[13] Stroke and bleeding reduction risk was assessed by comparing the normalized observed rate of events per year of follow-up with the expected rate of events per year derived from CHA_2DS_2-VASc and HAS-BLED scores as per validation studies.[14] For the cryoballoon ablation efficacy analysis, all supraventricular arrhythmias (atrial flutter, AF, or atrial tachyarrhythmia) lasting >30 seconds after a 3-month blanking period were considered.

Per study protocol, outcome analyses were performed at 6 months (short-term), 12 months (mid-term), and 24 months (long-term).

Statistical analysis

Statistical analyses were performed using Stata version 15.0 (StataCorp LLC, XXXX, TX). Normality for continuous variables was assessed using the Shapiro-Wilk test. Continuous variables were expressed as mean ± SD or as median (interquartile range) for normally and nonnormally distributed variables, respectively. Categorical variables were expressed as count (percentage). Kaplan-Meier survivorship estimates were used to summarize outcome data. Comparison analyses between groups were performed using the Student *t* test or the Kruskal-Wallis test, as appropriate. A *P* value of <.05 was considered significant.

Results

Baseline patient population

Forty-nine patients undergoing a combined LAAC and cryoballoon ablation procedure were enrolled (mean age 69 ± 8 years; 67% men). Paroxysmal AF was present in 51% of patients, whereas 33% and 17% suffered from persistent AF and long-standing persistent AF, respectively. Stroke (CHA_2DS_2-VASc) and hemorrhage (HAS-BLED) risk scores were 2.8 ± 1.2 and 3 ± 1, respectively. LAAC indications were as follows: (1) previous stroke/TIA despite antithrombotic therapy in 16 of 49 patients (33%), (2) previous major bleeding event(s) in 14 of 49 patients (29%), (3) labile international normalized ratio in 4 of 49 (8%), (4) blood dyscrasia with absolute antithrombotic therapy contraindication in 5 of 49 (10%), (5) chronic anemia from recurrent bleeding in 3 of 49 (6%), (6) high hemorrhagic risk (eg, HAS-BLED score >3) in 5 of 49 (10%), and (7) antithrombotic therapy intolerance/refusal in 2 of 49 (4%).

Table 1 reports baseline clinical characteristics.

Procedural data

All procedural data are reported in Table 2.

Cryoballoon ablation

A 28-mm first-generation and a second-generation cryoballoon was used in 9 (18%) and 40 (82%) cases, respectively. Total PV occlusion and acute PVI were achieved in all patients. One transient phrenic nerve palsy occurred while ablating the right superior PV; palsy complete resolution was demonstrated during the second follow-up visit (postprocedural day 60).

LAAC

The LAAC device was placed immediately after cryoballoon ablation. In 34 cases (70%), TEE and fluoroscopy imaging was used to guide the procedure, while in 15 (30%), ICE and fluoroscopy were used. In 6 (12%) cases, ICE was used alongside TEE, and these cases represented the early beginning of the ICE-guided LAAC experience at our center. An Amplatzer device was used in 39 patients (80%), while the Watchman device was used in 10 (20%). The acute implantation success rate was 100%, with only 3 patients (6%) requiring device recapture(s) and redeployment(s).

No major procedural complications were encountered, aside from 2 vascular complications (4%) (n = 1, self-resolving groin hematoma; n = 1, arteriovenous fistula requiring surgery). In 43 patients (88%), complete LAA occlusion was obtained, while in 6 (12%), <3 mm residual lateral flow was visualized at the end of the procedure. Of these 6 residual leaks, 5 (83%) were delivered under TEE guidance and only 1 (17%) under ICE guidance. At the time of the 24-hour cardiac ultrasound procedure, 4 patients (8%) had minimal pericardial effusion, with no need for percutaneous drainage.

Table 1 Baseline demographic characteristics (N = 49)

Characteristic	Value
Age (y)	69 ± 8
Sex: male	32 (67)
AF type	
Paroxysmal AF	25 (51)
Persistent AF	16 (33)
Long-standing persistent AF	8 (17)
LVEF (%)	54 ± 5
CHA_2DS_2-VASc score	2.8 ± 1.2
Chronic heart failure	4 (8)
Age between 65 and 74 y	26 (53)
Age >74 y	11 (22)
Hypertension	39 (80)
Vascular disease*	5 (10)
Diabetes	11 (23)
Previous stroke/TIA	23 (47)
On OAT	16 (70)
HAS-BLED score	3 ± 1
Impaired renal function	3 (6)
Impaired liver function	1 (2)
History of stroke	19 (39)
History of bleeding	28 (57)
Labile INRs	6 (12)
Drug abuse	3 (6)
Alcohol abuse	3 (6)
Inherited bleeding disorders	5 (10)
Hemophilia	3 (6)
von Willebrand	2 (4)

Values are presented as mean ± SD or as n (%).

AF = atrial fibrillation; INR = international normalized ratio; LVEF = left ventricular ejection fraction; OAT = oral anticoagulant therapy; TIA = transient ischemic attack.

*Defined as previous myocardial infarction, peripheral artery disease, or aortic plaque.

Table 2 Periprocedural data (N = 49)

Variable	Value
Cryoballoon PVI	49 (100)
Overall procedure time (min)	148 ± 31
Cryoablation procedure time (min)	107 ± 26
LAAC procedure time (min)	40 ± 9
Overall fluoroscopy time (min)	30 ± 6
Cryoablation fluoroscopy time (min)	22 ± 9
LAAC fluoroscopy time (min)	9 ± 2
Device	
Amplatzer	9 (80)
Watchman	10 (20)
TEE guidance	34 (70)
Complete occlusion	29 (86)
Residual (<3 mm) lateral flow	5 (14)
Pericardial effusion	3 (9)
ICE guidance	15 (30)
Complete occlusion	14 (94)
Residual (<3 mm) lateral flow	1 (6)
Pericardial effusion	1 (6)
Recapture and redeployments	
None	46 (94)
1	2 (4)
≥2	1 (2)
Major complications	
Drainage requiring pericardial effusion	0 (0)
Device embolization	0 (0)
Stroke/TIA	0 (0)
Vascular events	2 (4)
In-hospital length of stay (d)	3.2 ± 0.6

Values are presented as mean ± SD or as n (%).

ICE = intracardiac echocardiography; LAAC = left atrial appendage closure; PVI = pulmonary vein isolation; TEE = transesophageal echocardiography; TIA = transient ischemic attack.

Follow-up

All patients completed at least 24 months of follow-up with a median follow-up time of 42 months (interquartile range 25–58 months) and an average of 4 ± 1 follow-up encounters. Complete follow-up data have been reported in Table 3.

Arrhythmia recurrence

At the predefined scheduled times, 42 of 49 (85%), 37 of 49 (76%), and 29 of 49 (60%) patients were free from arrhythmia recurrences at the 6-, 12-, and 24-month follow-up visit, respectively. Kaplan-Meier curves are shown in Figure 1.

At 24 months, AF recurrences represented the main arrhythmic index event (11 of 20), followed by atrial tachyarrhythmias (7 of 20) and atypical atrial flutters (3 of 20). After arrhythmia recurrences, 11 patients (22%) elected to have redo ablation (n = 6, PVI touch-up due to PV electrical reconnection at long-term; n = 3, PVI radiofrequency touch-up and posterior wall electrical isolation; n = 2, posterior wall radiofrequency electrical isolation); the others were managed with antiarrhythmic drugs.

LAAC follow-up

All patients underwent scheduled 8-week and 6-month TEE. At 8 weeks, TEE demonstrated a complete or satisfactory appendage occlusion in 40 (82%) and 9 (18%) patients, respectively. At 6 months, the same parameters were recorded in 42 (86%) and 7 (14%) patients, respectively. Also, at 8 weeks, 2 interatrial shunts (4%) were detected: both cases resulted resolved at 6-month TEE. No device embolization/displacement was observed.

In 1 patient, at 8 weeks an echogenic structure (suspicious for device thrombosis) within a noncompletely occluded (<3 mm leakage) appendage was visualized; NOAC therapy was continued for another month, after which a TEE repetition demonstrated complete device occlusion with no residual thrombosis. A single ischemic stroke (64-year-old man treated

Table 3 Clinical follow-up data (N = 49)

Variable	Value
Follow-up time (mo)	42 (25–58)
Freedom from arrhythmia recurrences	
At 6 mo	42/49 (85)
Paroxysmal AF	23/25 (92)
Persistent AF	13/16 (81)
Long-standing persistent AF	6/8 (75)
At 12 mo	37/49 (76)
Paroxysmal AF	21/25 (84)
Persistent AF	11/16 (68)
Long-standing persistent AF	5/8 (63)
At 24 mo	29/49 (60)
Paroxysmal AF	17/25 (68)
Persistent AF	9/16 (56)
Long-standing persistent AF	3/8 (38)
Redo procedure	11/49 (22)
LAAC follow-up	
At 8 wk	
Complete occlusion	40/49 (82)
Satisfactory occlusion (<5 mm leak)	9/49 (18)
Interatrial residual shunt	2/49 (4)
At 6 mo	
Complete occlusion	42/49 (86)
Satisfactory occlusion (<5 mm leak)	7/49 (14)
Interatrial residual shunt	0/49 (0)
Device embolization	0/49 (0)
Device thrombus	1/49 (2%)
Ischemic events	1/49 (2)
TIA	1/49 (2)
Stroke	0/49 (0)
Major bleeding	2/49 (4)
Intracranial	0/49 (0)
Gastrointestinal	2/49 (4)
Pulmonary	0/49 (0)
Urinary	0/49 (0)
Observed annualized bleeding rate (%)	2
Observed annualized ischemic rate (%)	1
Death	1/49 (2)
VKA/NOAC off	
At 3 mo	42/49 (86)
At 6 mo	43/49 (88)
At 24 mo	45/49 (92)

Values are presented as median (interquartile range), as n/N (%), or as percentage.

AF = atrial fibrillation; LAAC = left atrial appendage closure; NOAC = non–vitamin K oral anticoagulant; TIA = transient ischemic attack; VKA = vitamin K antagonist.

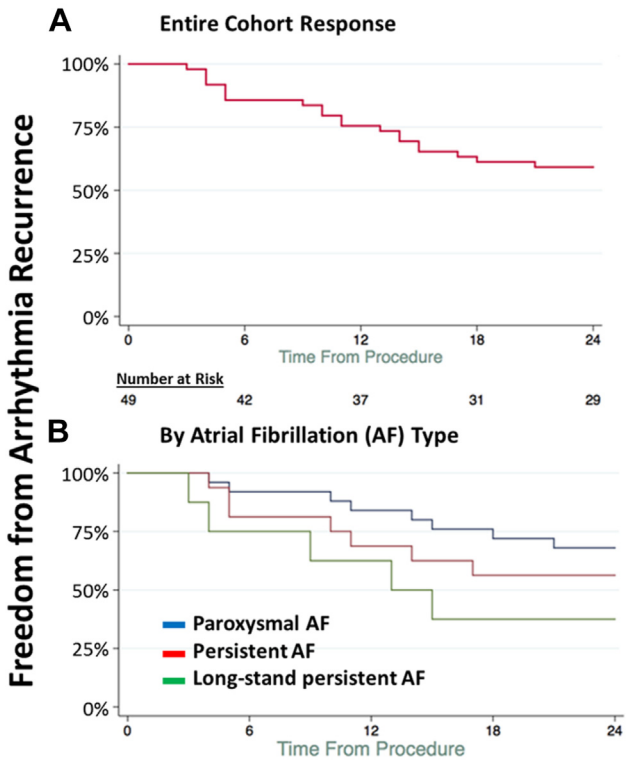

Figure 1 **A:** Overall long-term follow-up and freedom from arrhythmia recurrence. **B:** Long-term freedom from arrhythmia recurrence by atrial fibrillation type.

with dual antiplatelet therapy at 5 months from the procedure) was reported over 24 months of follow-up, resulting in a 1% observed annualized risk rate. The a priori expected stroke rate derived from the CHA_2DS_2-VASc score was 3.5% per year, resulting in a 71% stroke risk reduction. Two major bleeding events (4%) were observed (n = 1, gastric hemorrhage in a patient treated with a NOAC at 3 months; n = 1, severe large bowel bleeding in a patient treated with dual antiplatelet therapy), with no hemorrhagic deaths reported. The observed annualized bleeding rate was 2%, lower than the 4.9% per year a priori expected rate derived from the HAS-BLED score (60% bleeding risk reduction) (Figure 2).

Long-term antithrombotic therapy management

At 3 months, only 7 patients (14%) received oral anticoagulants (53% NOACs and 47% VKAs) because most patients had switched to either dual (6 patients [11%]) or single (28 patients [59%]) antiplatelet therapy. In addition, 8 patients (16%) received no therapy at all. At the 24-month follow-up visit, 4 patients (8%) received oral anticoagulant therapy, 5 (10%) used dual antiplatelet therapy, 26 (53%) used only a single antiplatelet drug, and 14 (29%) received no therapy at all. Consequently, the overall percentage of patients off oral anticoagulant therapy at 24 months was 92%, including patients experiencing arrhythmia recurrences. A graphical representation of therapeutic regimens is shown in Figure 3.

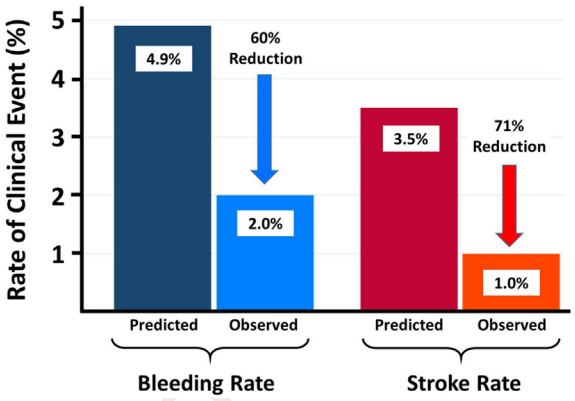

Figure 2 Annualized bleeding and stroke rate reduction from those risk predicted from HAS-BLED and CHA_2DS_2-VASc scores in our population after the combined procedure.

Discussion

To our knowledge, this study is the first long-term follow-up analysis on combined cryoballoon catheter ablation of AF and LAAC. Recently, 2 large and pivotal experiences of the combined procedure were published. Phillips et al[6] confirmed the safety and feasibility of the combined procedure approach and described favorable 30-day follow-up data in a large patient cohort. In addition, Wintgens et al[9] published the largest multicenter long-term combined procedure follow-up analysis, with ~350 combined procedures. The annualized thromboembolic and bleeding risk reduction reported in this second study was 76% and 71%, with a median follow-up time of 34.5 months. A 51% arrhythmia recurrence rate was reported by using radiofrequency as the only catheter ablation energy source for PVI. Long-term data on cryoballoon combined procedures are generally lacking (or limited to short-term follow-up), and the main aim of this study was to partially fill that void.

This study also aimed to strengthen feasibility and safety data on the combined procedure and its usefulness in a selected population of patients with nonvalvular AF.

Cryoballoon ablation and LAAC combined procedures

In our study, cryoenergy was chosen as the preferred energy source for PVI. According to recent AF ablation guidelines and position papers,[15,16] cryoablation has been proven to be as effective as radiofrequency in PVI and less associated with intraprocedural thrombi.[17]

An "extended" AF ablative approach (eg, posterior wall isolation or an isoprenaline challenge for extrapulmonary AF foci ablation), for which radiofrequency may be more effective, has not yet been introduced in the combined procedure protocol, and several recent experiences proved cryoablation PVI to be effective in both patients with persistent AF and those with long-standing persistent AF.[16] Consequently, cryoballoon ablation represents a viable option, as already demonstrated in a feasibility paper from our group,[3] of which this study represents a prosecution.

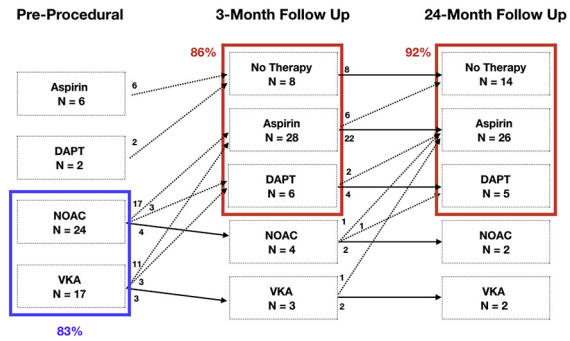

Figure 3 Changes in antithrombotic regimens during the study. *Full lines* indicate confirmed therapy; *dashed lines* indicate change in therapy. DAPT = dual antiplatelet therapy; NOAC = non–vitamin K oral antagonist; VKA = vitamin K antagonist.

In our population, acute procedural success was obtained in all patients, which is in accordance with recent articles reporting success rates of 97%–100%.[2,9,19] At long-term follow-up, we experienced a 60% recurrence rate, comparable to the one reported by Wintgens et al[9] when using radiofrequency and similar to those reported in the literature when stratifying by AF patterns.[20] When including redo ablation procedures, the overall freedom from arrhythmia rate increased from 60% to 75%.

Per protocol, our first procedure ablative approach was limited to PVI isolation; no electroanatomic mapping or isoprenaline challenge for the detection of extrapulmonary arrhythmic foci was performed. Although observed recurrence rates are in accordance with those in the literature for similar AF patterns, a future study including PVI, posterior wall isolation, and possibly LAA isolation as part of the combined procedure should be planned to try to further improve the arrhythmic outcome.

In agreement with LAAC success rates reported in other studies, successful device placement was obtained in all patients, with complete sealing at 6 months achieved in a high percentage of the population (88%). Only a small fraction of patients presented persistent residual lateral flow (<5 mm), which is not considered a predictor of thromboembolic events.[19] A single thromboembolic event was reported over the entire follow-up period. The patient had a completely sealed LAA at the 6-month follow-up visit but still developed an ischemic stroke. When comparing the observed and expected annualized stroke rates, the combined LAAC and cryoablation procedures appear to be effective in stroke risk reduction, reaching the 70%–75% stroke risk reduction reported in the scientific literature.[7]

No significant differences in arrhythmia recurrence, thromboembolic, or bleeding rates were found in patients undergoing LAAC with Amplatzer or Watchman devices, which is in agreement with previous experiences of combined procedures performed with a mixture of occluder devices.[3,5]

A high percentage of our population (88%) obtained freedom from oral anticoagulant therapy at the 6-month follow-up visit, regardless of arrhythmia recurrences. These data may support the idea of using a combined procedure in those patients with a high bleeding risk and who are expected to have arrhythmia recurrences (eg, patients with persistent or long-standing persistent AF). In case of a long-term failure of cryoballoon ablation, the LAAC device represents a good backup strategy, allowing the patient not to reinitiate the oral anticoagulant therapy upon arrhythmia recurrence.

Given the elevated bleeding risk of most candidates to this procedure, the main drawback is represented by the postprocedural anticoagulation regimen that should be continued for at least 2 months. Two hemorrhagic events were observed in our subpopulation, picturing a 60% bleeding risk reduction, which is slightly lower than the one reported in the literature.[9] In our opinion, this might depend on this postprocedural oral anticoagulation regimen. A lighter postprocedural antithrombotic drug may be proposed in the future, but only for a selected population with a lower a priori stroke risk.

Interestingly, no ischemic/bleeding events were experienced in the 5 patients with inherited bleeding disorders. This subpopulation represents a conundrum in treating AF because of the absolute contraindication to oral anticoagulation therapy. An Amplatzer device was preferred in this subpopulation because of a quicker de-escalating postprocedural drug regimen and LMWH for 2 months as postprocedural treatment was used. At long-term follow-up, none of those patients were receiving any treatment and the results were more than satisfactory. In this subgroup, the combined procedure is an option that at least deserves to be taken into consideration.

Finally, we also wish to highlight the low periprocedural complication rate experienced in our population (in accordance with the literature reported rates for experienced high flow centers)[9] while reducing the number of vascular access points and atrial septal punctures needed.[21,22]

ICE in the combined procedure: Our experience

Since 2016, we routinely use ICE technology for real-time guidance in device delivery. Only 15 patients underwent a combined procedure under ICE guidance, so the sample size is still too small to draw definitive conclusions.

Nonetheless, some first preliminary conclusions can be postulated: (1) In many centers, ICE can be routinely used during cryoablation procedures, and so the usage as a part of the LAAC procedure would not carry any extra monetary cost and could represent a viable alternative in patients with a contraindication to TEE imaging; (2) in our experience, ICE measurements of the LAA proved reliable, with no device embolization or the need for a different sized device after standard upsizing; (3) unlike TEE, ICE did not require either general anesthesia during the procedure or a dedicated operator. The main drawbacks of ICE usage were suboptimal color Doppler function and, to date, the unavailability of 3-dimensional reconstruction.

To date, the effect of ICE on LAAC and combined procedure has been analyzed only in small real-world clinical

experiences[23]: trials with a larger sample size are definitely needed for further evaluations and more solid conclusion.

Limitations

Our study is a retrospective study with a too small sample size to draw definitive conclusions. Although not statistically significant, the obtained arrhythmia recurrence rates (as well as stroke and bleeding risk reduction) are similar to the ones reported in the literature for similar procedures. The data set could (potentially) reach statistical significance if the sample size was increased, but further prospective studies are required to confirm these results. It should also be noted that the combined procedure as a whole is currently not part of any international guidelines and requires careful patient selection and individualized postdischarge antithrombotic therapy, representing a highly specific tailored therapy.

Conclusion

Q28 Our study proves the longer-term safety and efficacy of cryoballoon combined procedures. Given the increasing number of centers choosing cryoenergy as an AF ablation energy source over radiofrequency, the opportunity of using a similar approach for combined procedures should be considered. ICE usage in LAAC device deployment seems to offer some advantages that should be addressed in a separate and dedicated study.

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