

Same-day discharge following catheter ablation of atrial fibrillation: a safe and cost-effective approach

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Abstract

Introduction: The volume of AF ablation performed worldwide has increased dramatically. One approach to meeting this demand is to discharge patients on the day of treatment. There are limited data regarding the safety of this strategy.

Methods: We performed a retrospective analysis of all consecutive patients undergoing catheter ablation for AF in a tertiary centre and in a district general hospital (June 2016 - November 2019), and identified those discharged on the same day of treatment. The safety endpoint was any complication and/or presentation to hospital in the 48-hours post discharge. We also performed an economic analysis to calculate potential cost saving.

Results: Among a total population of 2628 patients, we identified 727 subjects (61.1±12.5 years, 69.6% male) undergoing day-case AF ablation. Most of them suffered from paroxysmal AF (58%) and underwent a *de novo* procedure (86.1%). Cryoballoon technique was used in 79.2% of the day-cases, and 91.6% of the procedures were performed under conscious sedation. 1.8% (13) of the participants met the safety composite endpoint, however only 0.7% (5) required at least one day of hospitalisation. Bleeding/haematoma at the femoral access site (0.5%) and pericarditic chest pain (0.5%) were the main reasons for readmission. None experienced cardiac tamponade or other life-threatening complications in the 48-hours post discharge. Our day-case policy resulted in a cost-saving of approximately £287,422 for our hospital (average of £83,927 annually).

Conclusion: In this large multicentre cohort, same-day discharge in selected patients following AF ablation appears to be safe and cost-effective, with a very low rate of early readmission or post discharge complication.

Key words: atrial fibrillation; catheter ablation; same-day discharge; outpatient; cost.

Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia, with an estimated 33.5 million people affected worldwide [1]. It has been described as an epidemic, and its prevalence continues to increase exponentially [2]. Catheter ablation has emerged as the most effective treatment for AF, particularly if paroxysmal, symptomatic, and refractory to antiarrhythmic drugs. Since its first description in the late 90's [3], the volume of AF ablation performed worldwide has increased dramatically [4-5], placing significant demands on healthcare resources. AF ablation is traditionally performed in an inpatient setting, with at least one overnight stay post-procedure. There is a growing interest in same-day discharge protocol following cardiac invasive procedures, such a strategy could not only improve patients' experience, but also reduce hospital logistic constraints and optimise cost effectiveness [6]. However, data regarding same-day discharge following AF ablation are still sparse. The aim of this study was to investigate the safety and cost-effectiveness of this approach.

Methods

Study design

We performed a retrospective analysis of all consecutive patients undergoing catheter ablation for AF in a high-volume cardiac centre and in a district general hospital between June 2016 and November 2019. Approval of the study was obtained from the quality improvement department. In June 2016 the units made a conscious decision to discharge all patients the same day following cryoablation for AF ablation where possible, and this was expanded to all patients undergoing AF ablation in August 2017. Patients not suitable for same-day discharge were identified by the referring physician or pre-assessment nurse based primarily on social, geographic and clinical factors, the very elderly or other major co-morbidities precluding safe

discharge. However, the final decision regarding timing of discharge was made by the operator at the end of the ablation and documented on the procedure report.

Catheter ablation procedure

Procedures were performed under either conscious sedation (midazolam and diamorphine) or general anaesthesia. All the patients were on either uninterrupted warfarin or direct oral anticoagulant. Written informed consent was provided prior to the procedure. Vascular ultrasound was mandatory for obtaining femoral venous access. No arterial access was routinely obtained. Patients received intravenous heparin to maintain an activated clotting time of 300–350 seconds. Single or dual transseptal puncture was performed under fluoroscopy and pressure guidance, with use of SafeSept® wire at discretion of the operator; direct visualisation with transoesophageal echocardiogram (TOE) was limited to cases under general anaesthesia. Pulmonary vein isolation (PVI) was the main procedural endpoint and was performed as a first step in all procedures. According to our policy, cryoballoon technique (Arctic Front, Medtronic, Inc) and radiofrequency (irrigated ablation catheters with contact-force sensing) were used for a majority of first-time and redo procedures, respectively; however, the final decision on the equipment and ablation strategy (i.e., PVI only vs. additional substrate modification) was at discretion of the operator.

If the patient was in AF at the start of the procedure and the arrhythmia organized into an atrial tachycardia this was mapped and ablated. In patients undergoing cryoballoon ablation, if the patient remained in AF after isolation of all four pulmonary veins, direct-current cardioversion to sinus rhythm was performed and no further ablation undertaken. Protamine sulfate was administered at the end of the case, sheaths removed and femoral haemostasis achieved with either Femstop™ (Abbott Vascular, Santa Clara, CA, USA) or haemostatic Z-suture. Post-

procedure transthoracic echocardiogram was performed routinely to exclude pericardial effusion.

Post procedure care, discharge, and follow-up

Patients were transferred to the elective ward and monitored for at least 4 hours. In the absence of clinical concerns, suitable patients were discharged by the nurse with no physician review on the same day, although all the patients were offered the option of staying overnight. Patients were routinely reviewed in the outpatient clinic at 3 months', and data regarding post discharge events and/or rehospitalisation were systematically collected at follow-up using a standardised electronic form.

Endpoints

The safety composite endpoint was any complication and/or presentation to hospital occurring in the 48-hours post discharge. We also aimed to perform a cost analysis and calculate potential cost saving for the hospital.

Statistical analysis

The chi-square test was used for categorical data and Student's t-test for comparison of means was used for comparison of continuous variables. Levene's test was used to check the homogeneity of variance; equivalent non-parametric tests were used when Kolmogorov–Smirnov was in favour of the absence of normal distribution. Results with $P < 0.05$ were regarded as significant.

Results

Among a total population of 2628 patients who underwent AF ablation during the study period (mean age 62.4±11.7, 62.7% male), we identified 727 subjects (27.7%; mean age 61.1±12.5, 69.6% male) undergoing day-case AF ablation. Most of the patients in the same-day discharge group suffered from paroxysmal AF (58%), had a structurally normal heart (79.8%), and underwent a *de novo* procedure (86.1%). Cryoballoon technique was used in 79.2% of the day-cases, and additional ablation beyond PVI (i.e., creation of left and/or right atrial lines or ablation of fractionated electrograms) was performed in 15.5% (113); acute procedural success defined as achieving PVI and restoring sinus rhythm was 98.9%. The large majority of the day-case procedures (91.6%) were performed under conscious sedation, and intraprocedural TOE was used only in 9.5% of the patients. Baseline demographic and procedural characteristics differed significantly between the day-case vs. overnight stay group (Table 1).

Overall rate of complications was 3.1% (Table 2). There was a significantly higher incidence of complications in the overnight stay group (3.8% vs. 1.6% $p=0.005$), however this was an expected finding as acute major complications precluded same-day discharge in most of the cases. Four patients who experienced phrenic nerve palsy post ablation were discharged on the same day. No acute deaths were identified, however one patient in the overnight stay group died a few weeks post procedure due to atrio-oesophageal fistula.

Safety endpoint

Thirteen patients (1.8%) in the same-day discharge group met the safety composite endpoint, however only 5 patients (0.7%) required at least one day of hospitalisation. The most common complications were 4 bleeding/haematoma at the femoral access site requiring thrombin injection (0.5%) and 4 pericarditic chest pain not requiring any intervention (0.5%). Two patients presented with haemoptysis (0.3%), one with nausea and vomiting (0.1%), one with

acute shortness of breath secondary to AF with fast ventricular (0.1%), and another one with minor femoral bleeding not requiring any intervention (0.1%).

None experienced cardiac tamponade or other life-threatening complications in the 48-hours post discharge. These results are shown in Table 2.

Temporal trend of same-day discharge

There was a progressive increase in the frequency of patients discharged on the same day post procedure, with a rate moving from nearly 20% in the initial 12 months to above 30% in the most recent periods. These results are shown in Figure 1.

Cost analysis

The cost of an overnight stay in hospital has been estimated at £400 at our institution and is a widely used figure in UK cost planning. Costs for accident & emergency department attendance are based on UK national tariffs at £106. Our day-case policy resulted in 727 patients discharged on the day of treatment, equating to an approximate cost-saving of £84,913 per year (total £290,800). After subtracting the cost of 13 attendances to accident & emergency (£1378) and the subsequent 5 unpredicted one-night admissions (£2000), the annual net cost-saving for the hospital was £83,927 (total £287,422).

Discussion

The main finding of the present study is that same-day discharge post AF ablation appears a safe approach in at least a third of patients, albeit selected to some extent. There was a very low rate of complications and/or need of urgent rehospitalisation in the 48-hour post procedure. None of the patients experienced life-threatening adverse events following discharge.

Over the last few decades, the accumulating expertise and improved technologies have allowed us to safely perform many procedures in an ambulatory setting that were traditionally performed as inpatient, often with prolonged hospitalisation. This transition involves several cardiac procedures, for example in 2014 over 50% of pacemaker/implantable cardioverter defibrillator surgery in the US were being performed in an ambulatory setting according to the Healthcare Cost and Utilization Project [7].

Catheter ablation has emerged as the most effective treatment for AF [8], and the volume of AF ablation performed worldwide has increased significantly over the last years [4-5]. Considering the limited healthcare economic and logistic resources, one approach to meeting this demand is to discharge patients on the day of treatment. Such a strategy could not only optimise healthcare resources, but also improve patients' experience. Indeed, several reports have demonstrated a higher patient satisfaction for same-day discharge compared to overnight stay following a number of cardiac procedures such as percutaneous coronary angioplasty [6] or rhythm management device implantation [9].

The results of our study allay some concerns regarding a day-case approach for AF ablation; in fact, less than 2% of the participants required urgent medical attention early post discharge, with subsequent need of at least one-day of rehospitalisation only in 0.7%. Femoral pseudoaneurysm and pericarditic chest pain were the most common reasons for re-admission, while no life-threatening complications were identified.

Of note, none of the patients in the day-case group experienced delayed cardiac tamponade, which is a common concern precluding early discharge in many electrophysiology centres. However, it should be highlighted that this serious complication can occur up to several days post procedure (median 12 days), therefore it is usually diagnosed post discharge even in patients admitted overnight [10].

To the best of our knowledge, we present the largest cohort of day-case AF ablation. Previous studies with smaller sample sizes have investigated the feasibility of this strategy. Opel et al [11] presented a series of 272 patients undergoing day-case AF ablation, reporting a high acute success rate and low rate of complications; however, the study was limited to cryoablation cases and was not specifically designed to compare a day-case vs. overnight stay protocol in terms of early post-discharge complications, indeed successful PVI was the primary endpoint. A recent small retrospective analysis of 143 day-case AF ablations in a tertiary UK centre demonstrated a 2.1% rate of early rehospitalisation and, consistently with our results, no life-threatening complications post discharge [12].

In our series, a majority of the patients in the same-day discharge group underwent cryoballoon ablation (79%), although this still leaves 151 patients safely undergoing day case ablation using radiofrequency ablation. In contrast, the overnight stay cohort where radiofrequency was used in 63% of the cases. However, this may reflect a patient selection bias rather than differences in the ablation technique itself. Patients requiring multiple AF ablations (i.e., radiofrequency ablation) tend to have more co-morbidities and require more extensive and longer duration procedures, with more frequent use of general anaesthesia. These procedures are necessarily performed with radiofrequency ablation and hence cases performed with this technology may be less suitable for same-day discharge. Interestingly, we noted a progressive increase of the annual rate of day-case AF ablation, which was mainly guided by procedures performed with radiofrequency (from 2% in 2015-2016 to 27% in 2018-2019). This finding reflects the increasing experience and confidence on the same-day discharge strategy even for higher risk patients/more complex procedures.

Finally, same-day discharge appears to be cost-effective. Beyond the direct economic advantages achieved by a reduction of the length-of-stay cost, there are also indirect advantages secondary to the possibility to open up beds for other inpatient admissions, allowing the

hospital to optimise bed-flow efficiency and operate at near maximal capacity. Where beds are not used overnight, this also means they are vacant at the start of the day for the next elective admission, rather than waiting for their discharge during the day. For health care systems and institutions with limited bed capacities this is likely to be another large advantage.

Limitations

Several limitations should be acknowledged. Firstly, this was a retrospective study. Despite a careful analysis of patients' electronic notes and a systematic and standardised collection of data regarding post-discharge complications at the time of follow-up, adverse events might be underestimated. Although potential candidates for day-case ablation were pre-selected, the final decision regarding discharge was left at the discretion of the operator performing the procedure, with no pre-defined criteria. The procedures were performed by highly experienced operators, therefore our results might not be generalisable to lower volume centres. Finally, there were several demographic and procedural differences between the day-case vs. overnight stay cohort, however a comparison of these two strategies was not the purpose of this study as we aimed to investigate the safety of same-day discharge in selected patients.

Conclusions

In this large multicentre cohort, same-day discharge in selected patients following AF ablation appears to be safe, with a very low rate of early readmission or post discharge complication. This approach appears to be cost-effective and may improve patient satisfaction.

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References

- [1] Chugh SS, Havmoeller R, Narayanan K, et al. Worldwide epidemiology of atrial fibrillation: a Global Burden of Disease 2010 Study. *Circulation*. 2014;129:837-847.
- [2] Ball J, Carrington MJ, McMurray JJ, Stewart S. Atrial fibrillation: profile and burden of an evolving epidemic in the 21st century. *Int J Cardiol*. 2013;167:1807-1824.
- [3] Haïssaguerre M, Jaïs P, Shah DC, Takahashi A, Hocini M, Quiniou G, Garrigue S, Le Mouroux A, Le Métayer P, Clémenty J. Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary veins. *N Engl J Med*. 1998; 339:659-666.
- [4] Kumar S, Walters TE, Halloran K, Morton JB, Hepworth G, Wong CX et al. Ten- year trends in the use of catheter ablation for treatment of atrial fibrillation vs. the use of coronary intervention for the treatment of ischaemic heart disease in Australia. *Europace*. 2013;15:1702–1709.
- [5] Kesek M, Englund A, Blomström-Lundqvist C, Karlsson LO, Kennebäck G, Poçi D, Samo-Ayou R, Sigurjónsdóttir R, Ringborn M, Herczku C, Carlson J, Fengsrud E, Tabrizi F, Höglund N, Lönnerholm S, Kongstad O, Jönsson A, Insulander P. A decade of catheter ablation of cardiac arrhythmias in Sweden: ablation practices and outcomes. *Eur Heart J*. 2019;40:820-830.
- [6] Heyde GS, Koch KT, de Winter RJ, Dijkgraaf MG, Klees MI, Dijkman LM, Piek JJ, Tijssen JG. Randomized trial comparing same-day discharge with overnight hospital stay after percutaneous coronary intervention: results of the Elective PCI in Outpatient Study (EPOS). *Circulation*. 2007;115:2299-2306.

- [7] Steiner CA (Institute for Health Research, Kaiser Permanente), Karaca Z (AHRQ), Moore BJ (IBM Watson Health), Imshaug MC (IBM Watson Health), Pickens G (IBM Watson Health). Surgeries in Hospital-Based Ambulatory Surgery and Hospital Inpatient Settings, 2014. HCUP Statistical Brief #223. May 2017. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/reports/statbriefs/sb223-Ambulatory-Inpatient-Surgeries-2014.pdf.
- [8] Creta A, Providência R, Adragao P, de Asmundis C, Chun J, Chierchia G, Defaye P, Schmidt B, Anselme F, Finlay M, Hunter RJ, Papageorgiou N, Lambiase PD, Schilling RJ, Combes S, Combes N, Albenque JP, Pozzilli P, Boveda S. Impact of Type-2 Diabetes Mellitus on the Outcomes of Catheter Ablation of Atrial Fibrillation (European observational multicentre study). *Am J Cardiol.* 2020;125:901-906.
- [9] Peplow J, Randall E, Campbell-Cole C, Kamdar R, Petzer E, Dhillon P, Murgatroyd F, Scott PA. Day-case device implantation-A prospective single-center experience including patient satisfaction data. *Pacing Clin Electrophysiol.* 2018;41:546-552.
- [10] Cappato R, Calkins H, Chen SA, Davies W, Iesaka Y, Kalman J, Kim YH, Klein G, Natale A, Packer D, Ricci C, Skanes A, Ranucci M. Delayed Cardiac Tamponade After Radiofrequency Catheter Ablation of Atrial Fibrillation: A Worldwide Report. *J Am Coll Cardiol.* 2011;13:2696-2697.
- [11] Opel A, Mansell J, Butler A, Schwartz R, Fannon M, Finlay M, Hunter RJ, Schilling RJ. Comparison of a high throughput day case atrial fibrillation ablation service in a local hospital with standard regional tertiary cardiac centre care. *Europace.* 2019;21:440-444.
- [12] Bartoletti S, Mann M, Gupta A, Khan AM, Sahni A1, El-Kadri M, Modi S, Waktare J, Mahida S, Hall M, Snowdon R, Todd D, Gupta D. Same-day discharge in selected patients undergoing atrial fibrillation ablation. *Pacing Clin Electrophysiol.* 2019;42:1448-1455.

Table 1.

Variable	Same-day discharge sample (n=727)	Overnight-stay (n=1901)	P
Age (years)	61.1±12.5	62.9±11.3	<0.001
Women	31.4% (228)	39.9% (759)	<0.001
Paroxysmal AF	58.0% (422)	48.8% (928)	<0.001
Persistent AF	42.0% (305)	51.2% (973)	<0.001
EHRA	2.6±0.5	2.7±0.6	0.06
NYHA	1.9±0.8	2.2±0.8	<0.001
Redo Procedure	13.8% (100)	40.4% (768)	<0.001
Ischemic heart disease	5.1% (37)	4.7% (89)	0.73
LA diameter	39.5±8.6	40.5±9.2	0.05
Structurally normal heart/preserved LVEF	79.8% (580)	73.3% (1394)	<0.001
Valvular heart disease	1.4% (10)	3.1% (59)	0.02
Cardiomyopathy	10.9% (79)	15.5% (295)	0.002
Previous cardiac surgery	2.1% (15)	6.3% (119)	<0.001
Cryoballoon ablation	79.2% (576)	37.4% (711)	<0.001
Use of General Anaesthesia	8.4% (61)	34.8% (661)	<0.001
Procedure Duration (min)	79±42	150±83	<0.001
Fluoroscopy Duration (min)	6.6±6.1	9.0±26.3	0.014
Class I or III AADs on discharge	49.0% (356)	47.5% (904)	0.51
Mitral isthmus line	3.0% (22)	16.1% (307)	<0.001
Roof line	4.5% (33)	22.8% (433)	<0.001
CTI	8.0% (58)	23.3% (443)	<0.001
Acute procedural success	98.9% (719)	97.8% (1859)	0.62
TOE	9.5% (69)	38.7% (735)	<0.001

Table 2.

Variable	Total sample (n=2628)	Same-day discharge (n=727)	Overnight Stay (n=1901)	P
Peri-procedural complications	3.2% (85)	1.6% (12)	3.8% (72)	0.005
Cardiac tamponade	1.6% (41)	0% (0)	2.2% (41)	<0.001
TIA	<0.1% (1)	0% (0)	<0.1% (1)	1.0
Stroke	0.1% (3)	0.1% (1)	0.1% (2)	0.82
Persistent phrenic nerve palsy	0.2% (5)	0.1% (1)	0.2% (4)	0.70
Major vascular complications	0.9% (24)	1.2% (9)	0.8% (15)	0.28
Procedure-related death*	<0.1% (1)	0% (0)	<0.1% (1)	1.0
Esophageal fistula*	<0.1% (1)	0% (0)	<0.1% (1)	1.0
Gastroparesis	<0.1% (1)	0% (0)	<0.1% (1)	1.0
Non-Access related bleeds§	0.1% (4)*	0.3% (2)	0.1% (2)	0.32
Bradyarrhythmic complications	<0.1% (2)	0% (0)	0.1% (2)	1.0
Air embolism	<0.1% (1)	0% (0)	<0.1% (1)	1.0
Pharyngeal perforation	<0.1% (1)	0% (0)	<0.1% (1)	1.0

* same patient; § spinal cord haemorrhage (1), haemoptysis (3)

Table 3.

Reason for presentation to hospital in the 48-hours post same-day discharge	% (N)	N of patients requiring at least 24-hour of rehospitalisation
Femoral haematoma/pseudoaneurysm requiring intervention	0.5% (4)	4
Minor bleeding at the femoral access site not requiring intervention	0.1% (1)	0
Pericarditic chest pain	0.5% (4)	1
Haemoptysis	0.3% (2)	0
Severe nausea and vomiting	0.1% (1)	0
AF with fast ventricular response	0.1% (1)	0

Figure 1.

