

Regional differences in referral, procedures, and outcome after ablation for atrial fibrillation in Europe: a report from the Atrial Fibrillation Ablation Pilot Registry of the European Society of Cardiology

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Aims

Ablation is an effective treatment of symptomatic and drug refractory atrial fibrillation (AF). Using data from the European AF Ablation Pilot Registry comprising 1410 patients from 10 European countries, we prospectively investigated regional differences in AF ablation regarding patient selection, ablation strategy, and outcome.

Methods and results

Countries were divided into three regions: South (Greece, Italy, Spain), East (Czech Republic, Poland), and West/North (Belgium, Denmark, France, Germany, and the Netherlands). One-year success was defined as patient survival free from atrial arrhythmia, with or without antiarrhythmic drugs (AAD). In all regions, patients were symptomatic and treated extensively with beta-blockers and AAD pre-ablation. Patients in East had more co-morbidity, increased thromboembolic risk, were more likely to have paroxysmal AF, and they underwent more left atrial linear ablations. Adverse events remained within expected levels, albeit with a significantly higher reporting of adverse cardiovascular events in the West/North (4.7 vs. 1.4 and 1.5% in South and East, $P = 0.0032$). There was no significant difference in peripheral/vascular, neurological, pulmonary, gastrointestinal, or general adverse events. The 1-year success rate after ablation differed non-statistically between regions ranging from 69.1 to 74.7%. A second ablation was performed in 23.2% in West/North compared with 10.5 and 16.5% in South and East. The proportion of patients still on AADs was highest in the South region (51.6 vs. 42.3 and 38.8% in East and West/North).

Conclusion

This study with all-comer patients shows that patient selection for ablation follows current guidelines but reveals significant differences regarding co-morbidity, medication, and ablation strategy. Despite this, 1-year outcomes are without significant differences and in line with previously published clinical trials.

Keywords

Atrial fibrillation • Ablation • Complications • Outcome • Registry

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What's new?

- Data from the Atrial Fibrillation (AF) Ablation Pilot Registry reveal that
- There are significant interregional differences in cardiovascular risk factors and co-morbidity in patients undergoing AF ablation.
- There is a significant difference between regions regarding antiarrhythmic treatment.
- Pulmonary vein isolation was the main strategy.
- There were no interregional differences in success rate of ablation for AF and outcomes.

Introduction

Ablation has emerged as an effective therapy in patients with symptomatic and drug refractory atrial fibrillation (AF).^{1–6} Catheter and surgical ablation remains a highly specialized procedure in which patient selection, the procedure itself, and concomitant medication are all important for the rate of success and complications.

Often, trials concerning catheter ablation of AF include only very experienced high-volume centres, and results may therefore not be applicable in other settings. However, as AF ablations become more widespread, it is important to standardize the procedure across different countries and health-care systems in order to improve overall quality of this treatment modality. While being a relatively confined geographical area, different parts of Europe exhibit important differences in terms of socioeconomic growth, health-care systems, and accessibility to AF ablation. In this analysis from the AF Ablation Pilot Registry, we prospectively investigated regional differences in the real-life setting for AF ablation regarding patient selection, ablation strategy, and outcome.

Methods

The design, baseline features, and results from the AF Ablation Pilot Registry have been previously published.⁷ In brief, the AF Ablation Pilot Study is a prospective registry designed to describe the clinical epidemiology of patients undergoing an AF ablation and the diagnostic/therapeutic processes applied across Europe. The AF Ablation Pilot Study was started in 2010. A total of 74 centres in 10 European countries, with an annual rate of >50 AF ablation/year in 2009, were asked to enrol 20 consecutive patients undergoing a first AF ablation procedure.

For this ancillary analysis, we focused on regional features of the population of ablation patients, their follow-up, and outcome. We divided countries into three regions: South (Greece, Italy, Spain), East (Czech Republic, Poland), and West/North (Belgium, Denmark, France, Germany, and the Netherlands) in order to compensate for some countries with low inclusion numbers.

Definitions

One-year success was defined as patient survival free from any atrial arrhythmia, with or without antiarrhythmic drugs (AAD), as assessed from the end of the 3-month blanking period to 12 months following the ablation procedure.

A blanking period of 3 months was employed after ablation. Recurrences within the first 3 months were not classified as failure of the procedure.

Arrhythmia recurrence was defined as an electrocardiographically documented episode of AF or atrial flutter lasting at least 30 s, after a 3-month blanking period.

Early recurrence was defined as a recurrence of any atrial arrhythmia, within 3 months from ablation.

Cavo-tricuspid isthmus-dependent flutter was excluded from all definitions.

Statistics

A univariate analysis was done for both the continuous and categorical variables. Continuous variables are reported as means $\pm$ standard deviation or as median and interquartile range (IQR). Among-group comparisons were made using a non-parametric test (Kruskal–Wallis test). Categorical variables are reported as percentages. Among-group comparisons were made using a χ^2 test or Fisher's exact test if any expected cells count was <5.

The Kaplan–Meyer estimator, the product limit estimator, was used for estimating and plotting the survival functions.

A *P*-value of <0.05 was considered statistically significant. All tests were two sided. Analyses were performed with the SAS system software (SAS Institute, Inc., Cary, NC, USA).

Results

The final population in the AF Ablation Pilot Registry included 1410 patients, of which 1391 underwent an AF ablation (98.7%). Detailed information on the demographics and baseline clinical characteristics has previously been published, and there is some overlap in the presented results and the present paper.⁷

Characteristics of the participating centres

Totally, 70 European centres participated in the study (Southern 23, Eastern 10, and West/Northern 37). Of these, Seventeen (25.7%) were community or district hospitals, 38 (57.6%) university hospitals, and 11 (16.7%) were private clinics. There were no significant inter-regional differences (*P* = 0.74).

The number of AF ablations performed per year per centre was significantly higher in the West/Northern region (*P* = 0.006). The median (interquartile range) total number of AF ablations per year was 159.5 (80–327) [90 (55–179) in Southern countries, 91 (60–346) in Eastern countries, and 242 (113–360) in Western/Northern region].

Cardiovascular risk factors and co-morbidity

Baseline characteristics of ablation patients according to region are summarized in Table 1.

Patients from the Eastern countries had significantly more hypertension and hypercholesterolaemia (*P* = 0.0002 and *P* < 0.0001, respectively) and were more likely to be active smokers (*P* = 0.0257). Previous myocardial infarction, diabetes, and chronic kidney disease were most prevalent in the Eastern countries, but the difference with other regions was statistically non-significant.

Table 1 Baseline characteristics of patients according to region

	Total (n = 1391)	Southern (n = 417)	Eastern (n = 194)	Western/Northern (n = 780)	P-value
Females (%)	27.9	26.9	30.9	27.7	0.5695
Age (years)					
Median (IQR)	60 (52–66)	58 (50–65)	60 (53–66)	61 (53–67)	0.0006
>65 years (%)	31.2	26.0	28.9	34.6	0.0071
Body mass index (kg/m ²)					
>30 kg/m ² (%)	25.8	25.6	29.4	25.0	0.4569
Cardiovascular risk factors (%)					
Diabetes mellitus	8.3	8.6	11.3	7.4	0.1894
Hypertension	50.1	47.8	63.9	47.9	0.0002
Active smokers	12.1	12.8	17.5	10.4	0.0257
Hypercholesterolaemia	32.5	26.6	51.3	31.0	<0.0001
Valvular heart disease	12.3	13.4	17.5	10.4	0.0178
Acute myocardial infarction	1.3	1.0	1.5	1.4	0.7614
Co-morbidities (%)					
Chronic kidney disease	1.8	0.5	2.6	2.3	0.0521
Chronic obstructive pulmonary disease	3.2	1.7	2.1	4.4	0.0262
Peripheral vascular disease	2.0	0.7	2.6	2.6	0.0792
Implanted devices					
PM	2.9	1.2	3.1	3.7	0.0445
ICD	1.3	1.0	1.0	1.5	0.6568
CRT	0.3	0	0	0.5	0.4599 ^a
Previous thromboembolism (%)					
Stroke/TIA	6.8	5.8	8.2	6.9	0.5063
Peripheral embolism	1.1	0.5	1.0	1.4	0.4069 ^a
Pulmonary embolism	0.8	0.2	1.0	1.0	0.2924 ^a
CHA2DS2-VASc					
Mean ± SD	1.7 ± 1.4	1.5 ± 1.3	1.8 ± 1.3	1.8 ± 1.4	
Indications for ablation (%)					
Symptoms	89.7	83.5	92.8	92.3	<0.0001
Quality of life	73.4	71.5	81.4	72.4	0.0224
Desire for drug-free lifestyle	34.9	35.0	51.5	30.8	<0.0001
Desire for sinus rhythm	39.6	38.8	65.5	33.6	<0.0001
Type of AFib (%)					
Paroxysmal AF	66.8	64.7	73.7	66.2	0.0059
Persistent AF	27.6	31.4	18.6	27.8	
Permanent AF	4.5	2.4	6.7	5.0	
Not defined	1.2	1.4	1.0	1.0	
Pre-procedural evaluation					
Transthoracic Echocardiogram (%)	58.4	58.9	89.2	50.5	<0.0001
Transoesophageal echocardiogram (%)	67.3	64.3	64.9	69.5	0.1354
Holter (%)	23.7	16.5	19.6	28.6	<0.0001
Electrophysiology study (%)	13.9	32.0	5.7	6.3	<0.0001
CT scan	49.9	34.3	64.4	54.7	<0.0001
MRI scan	10.6	14.4	12.9	8.1	0.0019

Unknown or missing values are not taken into account.

Southern (Greece, Italy, Spain), Eastern (Czech Republic, Poland), West/Northern (Denmark, Belgium, France, Germany, and the Netherlands).

IQR, interquartile range; PM, pacemaker; ICD, implantable cardioverter defibrillator; CRT, cardiac resynchronization therapy; TIA, transient ischaemic attack.

^aFisher's exact test.

The proportion of patients with previous thromboembolism was not statistically different between regions. However, the prevalence of stroke risk factors showed marked differences between regions. The proportion of patients in the Eastern countries with a CHADS₂ score of ≥ 2 was 26.8% compared with the Southern and Northern/Western countries (17.0 and 16.5%, respectively) ($P = 0.0080$). The proportion of true low-risk patients with a CHA₂DS₂-VASc score of 0 was significantly higher in the Southern countries (26.1%) compared with the Eastern and Northern/Western countries (16.0 and 19.7%, respectively) ($P = 0.0036$).

Indications, type of atrial fibrillation, and pre-procedural evaluation

Indications, type of AF, and pre-procedural evaluation are summarized in Table 1. In all regions, symptoms due to AF and reduced quality of life were most commonly indicated as the reason for ablation. However, in the Eastern region, patients' desire for a drug-free lifestyle and sinus rhythm were important factors in deciding for ablation.

A significantly higher percentage of patients underwent ablation due to PAF in the Eastern region compared with the other regions [73.7 vs. 64.7% (Southern) and 66.2% (Northern/Western), $P = 0.0059$]. Lone AF was reported as the underlying disorder in 38.2% of cases (44.4% Southern, 23.2% Eastern, and 38.7% Western/Northern countries). This interregional difference was highly significant ($P < 0.0001$).

The data on pre-procedural evaluation of patients revealed significant interregional differences. Standard transthoracic echocardiography was performed in 58.9 and 50.5% of patients, respectively, in the South and North/West regions. However, in the East region, echocardiography was performed in 89.2% of cases ($P < 0.0001$). The use of transoesophageal echocardiography was without

statistical differences between the regions and was performed in 67.3% of patients prior to the ablation procedure.

The Holter monitoring was used more extensively before ablation in the Northern/Western region (28.6%), whereas the Southern and Eastern regions used the Holter monitoring in 16.5 and 19.6% of cases, respectively. In the South region, significantly more electrophysiology studies were performed before ablation (32.0%) when compared with the East and North/West regions (5.7 and 6.3%, respectively) ($P < 0.0001$). Computed tomography (CT) and magnetic resonance imaging (MRI) scans prior to the ablation procedure were performed in significantly fewer patients in the South region (34.3 and 14.4%, respectively) when compared with the East and North/West regions (64.4 and 12.9%, respectively, and 54.7 and 8.1%, respectively) ($P < 0.0001$ for CT and $P = 0.0019$ for MRI).

An analysis of whether there was a relationship between indication for ablation and arrhythmia outcome revealed no difference between the regions (data not shown).

Medication

Table 2 summarizes medication before AF ablation, revealing significant differences between regions as well as reflecting local tradition and availability of some drugs. Seventy-three per cent of all patients were treated with vitamin K antagonists (VKA) before ablation. However, the proportion of patients on the VKA treatment was higher in the Eastern region (87.6%) vs. Southern and Western/Northern regions (64.7 and 74.0%, respectively) ($P < 0.0001$).

The proportion of patients on the VKA treatment before ablation for PAF was significantly lower in the Southern region (53.3%) compared with the other regions [86.0 and 73.8, respectively (Eastern and Northern/Western)] (Supplementary material online, Table S1).

In the Southern and Eastern regions, low-molecular-weight heparin (LMWH) was used before ablation (presumably as bridging

Table 2 Medication before AF ablation

	Total (n = 1391)	Southern (n = 417)	Eastern (n = 194)	West/Northern (n = 780)	P-value
Antithrombotic treatment					
VKA	73.1	64.7	87.6	74.0	<0.0001
Antiplatelets	17.5	19.7	11.9	17.8	0.0586
LMWH	29.7	34.3	36.6	25.5	0.0005
Other pharmacological treatments					
Amiodarone	23.2	18.9	18.1	26.8	0.0019
Dronedarone	6.7	5.3	2.6	8.5	0.0047
Propafenone	11.8	17.5	38.1	2.2	<0.0001
Flecainide	22.7	27.2	0	26.0	<0.0001
Other antiarrhythmic	10.3	9.9	12.4	10.1	0.5861
ACE-I/ARBs	40.9	41.0	53.6	37.6	0.0003
Beta-blockers	52.6	40.3	65.5	56.1	<0.0001
Aldosterone blockers	2.5	1.4	4.6	2.5	0.0588
Digitalis	5.3	1.7	3.6	7.7	<0.0001
Diuretics	18.2	13.7	13.9	21.7	0.0007
Calcium channel blockers	12.8	10.6	14.4	13.5	0.2534
Statins	25.2	18.5	40.2	25.0	<0.0001

from VKA or other oral anticoagulant treatment) in more than one-third of patients, while only 25.5% of Western/Northern patients received LMWH ($P = 0.0005$). This pattern of VKA/LMWH use remained the same, regardless of the type of AF, i.e. paroxysmal or permanent/persistent (Table 2).

Antiarrhythmic drugs were used differently in the three regions. The most widely used drugs were amiodarone and class Ic (propafenone and flecainide). The proportion of patients treated with amiodarone was higher in the West/Northern cases prior to the ablation procedure, and for permanent/persistent AF, this association was statistically significant with 34.9% in the Western/Northern regions vs. 23.4 and 26.5% in the Southern and Eastern regions, respectively ($P = 0.0484$) (Supplementary material online, Table S2). The total proportion of patients on class IC drugs was higher in the Southern region [17.5% propafenone and 27.2% flecainide vs. Eastern (38.1% propafenone) and Western/Northern (2.2% propafenone and 26.0% flecainide ($P < 0.0001$)). This trend remained the same for both paroxysmal and permanent/persistent AFs.

Beta-blockers were extensively used in all regions with [65.5% in East vs. 40.3% in South ($P < 0.0001$)]. Digitalis was primarily used in the Western/Northern region (7.7%) and significantly more than in the Southern (1.7%) and Eastern (3.6%) ($P < 0.0001$).

After discharge, there was no regional difference in the rate of VKA treatment (data not shown). However, the observed pre-hospital interregional differences in antiarrhythmic and other medication were unchanged.

Ablation procedure and strategy

As shown in Table 3, the percentage of procedures performed in general anaesthesia during the ablation procedure was higher in the Western/Northern countries ($P < 0.0001$). Radiofrequency with open irrigation was the most frequently used energy source in all regions, and there were regional differences (82.2% Southern vs. 63.9% Eastern, $P < 0.0001$). In addition, there were regional differences with cryo-ablation being very prevalent in the Eastern and Western/Northern regions (24.2 and 18.8%, respectively).

Table 3 Periprocedural data by region and ablation strategy by region

Periprocedural data	Total (n = 1391)	Southern (n = 417)	Eastern (n = 194)	Western/Northern (n = 780)	P-value
General anaesthesia during procedure (%)	21.2	15.6	2.6	28.8	<0.0001
Energy source (%)					
Non-irrigated radiofrequency	4.0	5.8	8.8	1.8	<0.0001
Radiofrequency with closed irrigation	2.2	2.4	0	2.6	0.0786
Radiofrequency with open irrigation	78.1	82.2	63.9	79.5	<0.0001
Cryo	13.5	2.4	24.2	16.8	<0.0001
Duty-cycled radiofrequency energy	4.4	5.3	1.0	4.8	0.0432
Laser balloon (endoscopic ablation system)	0.8	0	2.1	0.9	0.0146 ^a
Procedure duration (min), median (IQR)	180 (130–220)	180 (134–215)	200 (150–260)	170 (125–210)	<0.0001
Fluoroscopy total time (min), median (IQR)	26 (15–45)	36 (18–54)	22 (14–39)	24 (14–39)	<0.0001
Transoesophageal echocardiogram (%)	10.5	1.7	0	17.8	<0.0001
Intracardiac echocardiogram	17.9	19.2	52.6	8.6	<0.0001
Ablation strategy					
Left atrial linear lesion (%)					
Roof line	19.3	14.6	24.2	20.5	0.0081
Mitral isthmus line	12.8	13.2	22.7	10.1	<0.0001
Other left atrial linear lesion	8.1	9.1	12.4	6.4	0.0165
Right atrial linear lesion (%)					
Superior vena cava	2.6	3.6	2.6	2.1	0.2857
Cavotricuspid linear lesion	17.4	12.0	12.9	21.5	<0.0001
Achievement of bidirectional CTI block ^b	90.9	84.0	88.0	93.4	0.0856 ^a
Ablation of fractionated electrograms (%)					
In the left atrium	17.4	18.2	21.1	16.0	0.2117
In the right atrium	5.0	5.8	3.6	5.0	0.5274
Ablation of fractionated sites slowed activation or terminated AF ^b	50.6	28.8	53.7	63.3	<0.0001
Ablation of autonomic ganglionated plexi	3.3	7.2	4.1	1.0	<0.0001

CTI, cavo-tricuspid isthmus.

Unknown or missing values are not taken into account.

Missing values are not taken into account.

^aFisher's exact test.

^bWith regard to patients in whom ablation was attempted.

compared with the Southern region where cryo-ablation was used in only 2.4% of cases ($P < 0.0001$).

Non-irrigated radiofrequency was primarily used in Eastern region (8.8%) and Southern region (5.8%), while Western/Northern region largely had abolished its use ($P < 0.0001$).

Use of 3D mapping system was significantly higher in the Southern region (86.3%) compared with the Eastern and West/Northern regions (72.2 and 75.4% respectively, $P < 0.0001$).

There was also a significant difference ($P < 0.0001$) in use of remote navigation and ablation system (Southern region 1.4%, Eastern region 8.8%, and West/Northern regions 10.6%).

The median procedure duration was longer in the Eastern region compared with the Southern and Western/Northern (200 vs. 180 and 170 min, respectively, $P < 0.0001$).

Periprocedural transoesophageal echocardiography was most prevalent in the Western/Northern region (17.8%) and virtually absent in the Southern and Eastern regions ($P < 0.0001$). Conversely, a large number of procedures in the Eastern and Southern regions were performed with guidance by intracardiac echocardiography [52.6% (Eastern) and 19.2% (Southern) vs. 8.6% (Western/Northern) ($P < 0.0001$)].

The ablation strategy and regional differences are shown in Table 3. Attempt of pulmonary vein (PV) isolation was the main strategy. Linear left atrial lesions were significantly more often performed in the Eastern region including left mitral isthmus lines. Roofline ablation, in the Eastern region, was performed primarily in patients with persistent/permanent AF (65%) and in 9.8% of patients with PAF. This was also the case for mitral isthmus line (63.3 and 8.4%, respectively). Other left atrial linear lesions were performed in 38.8% of patients with persistent/permanent AF and

3.5% of patients with PAF in the Eastern region. Although the percentage of performed left atrial linear lesion was higher in the Eastern region, the same strategy was used in the other regions where the left atrial lesions were made predominantly in patients with persistent/permanent AF.

Other left atrial linear lesions were performed more often in the Eastern region (12.4%) compared with Southern (9.1%) and West/Northern (6.4%) ($P = 0.0165$).

There was no regional difference in ablation of fractionated electrograms, which was performed mostly in patients with persistent/permanent AF (data not shown).

Ablation of autonomic ganglionated plexi was performed more often in the Southern region (7.2% of the cases compared with 4.1% in Eastern and 1.0% in West/Northern countries, $P < 0.0001$), however, predominantly in patients with persistent/permanent AF (11.3 vs. 5.2% in patients with PAF). This was also the case in Western/Northern (1.6 and 0.8%) and Eastern patients (10.2 and 1.4%).

Adverse events and complications

The adverse events and complications related to ablation procedure are presented in the Supplementary material online, Table S3. There was a significantly higher reporting of adverse cardiovascular events in the Western/Northern countries (4.7%), predominantly pericarditis and cardiac perforation, while the Southern and Eastern countries reported cardiovascular complications in 1.4 and 1.5% of cases, respectively ($P = 0.0032$). There was no significant difference in reported peripheral/vascular, neurological, pulmonary, gastrointestinal, or general adverse events. However, the reported number of adverse events, classified as 'other', was significantly higher in

Table 4 Survival free from any atrial arrhythmia follow-up and outcome according to region after AF ablation

Type of follow-up	Total (n = 1300)	Southern (n = 401)	Eastern (n = 188)	West/Northern (n = 711)	P-value
Type of follow-up at 12 months (%)					
Clinical visit	58.2	68.5	65.2	50.4	<0.0001
Telephone contact	41.8	31.5	34.8	49.6	
At least one ECG during follow-up (%)	87.2	92.2	94.4	82.5	<0.0001
Type of ECG monitoring (%)					
ECG	76.6	78.4	83.0	73.9	0.0186
Holter monitoring	52.9	64.4	55.6	45.6	<0.0001
Transtelephonic monitoring	8.4	15.8	20.2	0.9	<0.0001
Implanted-monitoring systems	4.4	8.5	1.6	2.9	<0.0001
ECG + multiday recording	53.6	65.5	66.0	43.5	<0.0001
None	18.4	13.5	14.4	22.4	0.0004
Freedom from AF					
Success rate (%)	73.7	74.1	69.1	74.7	0.3030
Second ablation procedure (%)	18.3	10.5	16.5	23.2	
Percutaneous catheter ablation (%)	85.1	82.9	96.7	83.5	
Surgical (%)	4.3	4.9	0	4.9	
Other cardiac procedures (%)	10.6	12.2	3.3	11.6	
Antiarrhythmic treatment at the 12 month evaluation ^a	43.3	51.6	42.3	38.8	

^aFor subjects in success only.

the Western/Northern countries, 3.6 vs. 0 and 1.0% (Southern and Eastern) ($P < 0.0001$).

One-year follow-up

Totally, 1300 patients had a 1-year follow-up (Table 4). There was a significant interregional difference in type of follow-up and electrocardiogram (ECG) monitoring as previously reported.⁸

The reported rate of readmission due to tachycardia, secondary to AF/flutter, other cardiovascular or non-cardiovascular events was significantly higher in the Western/Northern region (Supplementary material online, Table S4).

There were no differences in percentage of patients with sinus rhythm at 12-month follow-up (88.3, 86.0, and 88.5% in Southern, Eastern, and West/Northern cases, respectively).

The Kaplan–Meyer curves displaying the time to first recurrence of AF are shown in Figure 1. A similar pattern is seen across regions with persistent/permanent AF displaying a significantly poorer AF-free survival compared with paroxysmal AF.

Outcomes at the follow-up of 1 year after ablation are summarized in Table 4. The overall success rate after ablation differed slightly but non-statistically between regions ranging from 69.1 to 74.7%. To achieve this, 23.2% underwent a second AF ablation in the Western/Northern region compared with 10.5 and 16.5% in the Southern and Eastern regions. The proportion of patients still on AADs was highest in the Southern region (51.6%) compared with the Eastern and Western/Northern regions (42.3 and 38.8%, respectively).

The success rate according to the type of AF is depicted in Figure 2, revealing similar outcomes across the three regions. Success rates and the use of AADs at 1-year follow-up according to AF type are shown in the Supplementary material online, Table S5.

Discussion

Atrial fibrillation is the most common arrhythmia worldwide and gives rise to a number of complications that confer a major public health burden, the most important being the increased risk of stroke.^{9,10} While anticoagulants effectively reduce the risk of stroke,¹¹ many patients are highly symptomatic due to AF and may thus be eligible to ablation treatment according to current guidelines.^{12,13} The AF Ablation Pilot Study was initiated as a part of EURObservational Research Programme in 2010 and has since provided important epidemiological data regarding management and outcomes of catheter ablation of AF in Europe.^{7,8}

This study shows that in the everyday clinical setting, European patients undergoing AF ablation, across different regions, are selected according to current guidelines. Further, that 1-year success and complication rates remain within expected and previously published levels across the regions. The study does, however, reveal regional differences with regard to patient selection and treatment strategy.

Patient selection

There is an existing global/regional difference in the incidence of stroke, with most of the burden in low- and middle-income countries.¹⁴ Stroke risk quantified by the CHA₂DS₂-VASc score has also been shown to differ within the European countries, being significantly higher in the Eastern and Southern countries in patients with AF.¹⁵

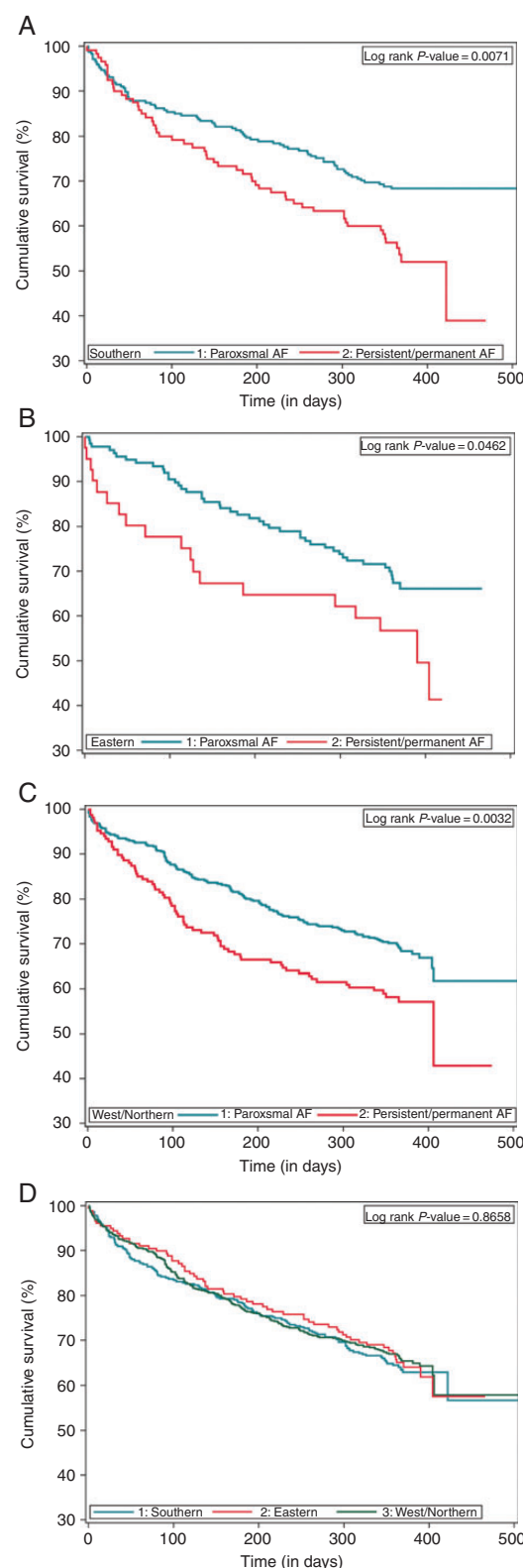


Figure 1 (A–C) The Kaplan–Meyer curve displaying the freedom from AF as time of first reported recurrence by type after catheter ablation in different regions (A: South; B: East; C: West/North). (D) The Kaplan–Meyer curve displaying the freedom from all types of AF by region.

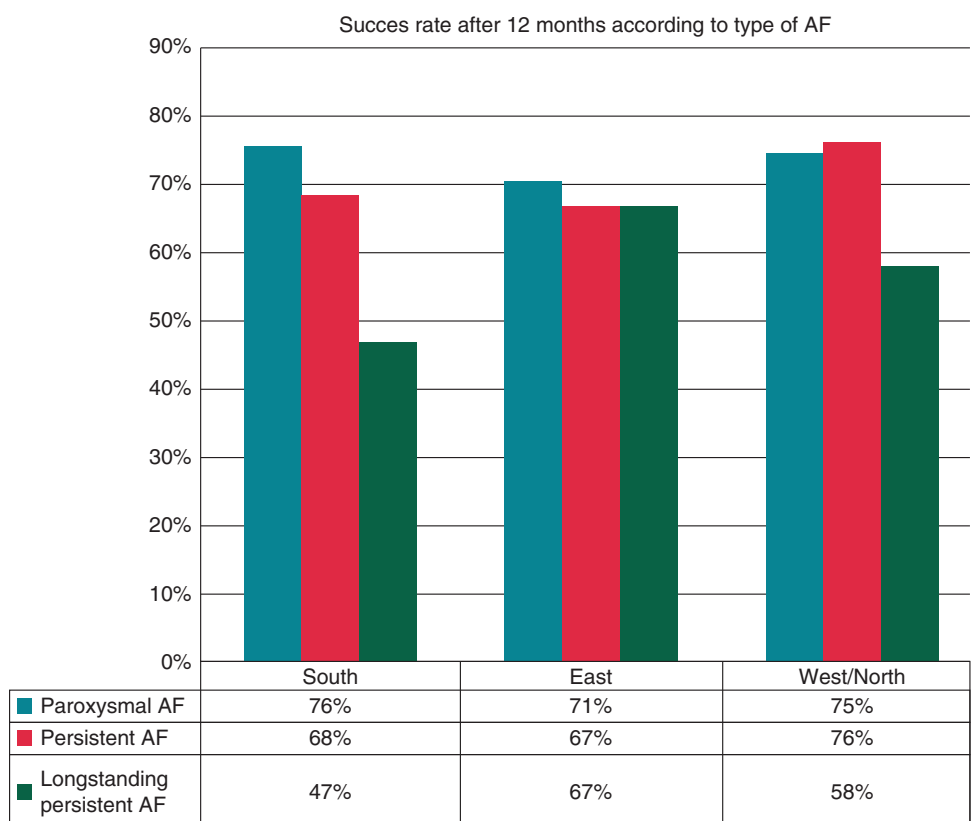


Figure 2 Success rate after 12 months according to the type of AF and region.

Data from this study show a significant higher proportion of patients with a CHADS₂ score of ≥ 2 in the Eastern countries compared with the Southern and Northern/Western countries, who were referred to radiofrequency ablation treatment. Conversely, the proportion of low-risk patients with a CHA₂DS₂-VASC score of 0 was significantly higher in the Southern countries compared with the Eastern and Northern/Western countries. Also the prevalence of co-morbidity in terms of hypertension and hypercholesterolaemia was significantly higher in the Eastern region. These findings confirm data previously published by Lip *et al.* regarding regional differences in presentation and treatment of patients with AF in Europe.¹⁵

Radiofrequency ablation for AF was performed more often in patients with lone AF in the Southern and Western/Northern countries compared with the Eastern region, which reflects the finding of higher CHA₂DS₂-VASC score and increased co-morbidity in the Eastern patients.

Paradoxically, the desire for a drug-free lifestyle as a reason to perform ablation was highest in the Eastern region. However, considering the highest prevalence of associated conditions including hypertension and diabetes in that region, this desire is the inverse of the need for chronic drug treatment for those associated conditions. It may therefore be an important message to all clinicians that the benefit of ablation therapy should never be presented to patients as an opportunity to stop otherwise beneficial cardiovascular drugs.

Ablation strategy

Electrical PV isolation by creation of circumferential lesions around PV ostia has been the most common ablation strategy in catheter-based treatment of AF and remains the recommended initial approach.⁴ In 2010, when these study data were collected, linear lesions in the left atrium were performed extensively in many centres, predominantly in patients with persistent/chronic AF. Even though the percentage of patients with PAF was higher in the Eastern region, a more extensive ablation strategy with additional linear ablation lines was performed more often in the Eastern region when compared with the two other regions. Recent publications point towards performing only limited and targeted ablations in the left atrium beyond PV isolation in patients with persistent/chronic AF.^{16,17}

Complications and adverse events

The rate of adverse events and complications following AF ablation is in line with previous reports.^{4,18} However, there is a marked disparity in the reporting of complications, with a significantly higher number of complications reported in the Western/Northern region. This suggests that differences in follow-up procedures and awareness of complications and adverse events may play a role.

Given these caveats, the number and nature of complications in this registry from the real world setting are reassuring. The number of reported serious and life-threatening complications is low. In all regions, the results are thus consistent with the guidelines' notion

that AF ablation is first and foremost a symptomatic treatment and that it should only be offered to patients with a favourable risk/benefit ratio.⁴

Outcome at 1 year

This represents the largest follow-up of all-comer patients to date, where 1300 patients completed the 1-year follow-up. There were no significant differences between regions in the proportion of patients that remained in sinus rhythm (Figures 1 and 2). Remarkably, patients can expect the same outcome in all European regions, despite differences in patient selection with East European patients having significantly more co-morbidity. This may owe to a more aggressive ablation strategy, with more extensive linear ablations performed in the Eastern region. However, it may also relate to the relatively high inclusion of paroxysmal AF patients.

Overall, 73.7% of patients experienced freedom from AF. However, between 10.5 and 23.2% had to undergo a second ablation procedure to achieve sinus rhythm at 1 year. The proportion of second ablation procedures was highest in the Western/Northern region, suggesting a more aggressive approach to recurrences. Further, a total of 43.3% of these patients remained on AADs after 1 year (51.6% in the Southern region).

The reported success rates from different regions are in line with previously reported results from several trials^{1,3,5,19–21} and are therefore reassuring, as these results were not obtained in the framework of a clinical trial but rather in the daily clinical setting.

Limitations

This study has several limitations due to the fact that it is registry based with voluntary participation of the centres involved, therefore leading to a substantial risk of inclusion bias. However, 73% of the invited centres participated in the study minimizing this risk. No local audit was performed, which may lead to differences, e.g. under-reporting of complications. As this is a registry-based study, the results of the study should be considered as hypothesis generating.

The 'arbitrary' division of the participating countries into three groups may be subject to discussion, as one may argue that another regional distribution with only a few changes may produce entirely different results. Nevertheless, a regional distribution as proposed here makes sense from both a socioeconomic and geographical/historical perspectives. The regional groups are numerically unbalanced because the participation of the European countries in the present pilot registry was mainly based on the willing of the Cardiology National Societies to be involved rather than on their geographical distribution. This may imply some unbalance also on characteristics of the regional populations. On the other hand, the limited number of patients per country makes any analysis of inter-country differences underpowered.

The post-ablation registration of arrhythmias (type of follow-up and ECG monitoring) was not predefined, and there is, therefore, a risk of misinterpretation of AF recurrence, and, for sure, a loss of most asymptomatic recurrences.

The participating centres were medium and high expertise centres, and the results of the study can theoretically be more positive than in the real-life setting, where many small centres add to the total volume of AF ablations. The presented registry data are based on centres that voluntarily participated. The participating centres do

therefore not necessarily reflect the activity of a whole region. Nevertheless, every centre had opted to participate with 20 cases, and activity can therefore be said to be representative of individual centres. Although centres were recruited through the European Heart Rhythm Association organization, the participating centres were not confined to a small number of high-volume centres usually participating in trials. This registry therefore provides a good picture of the selection, treatment strategy, and outcome for the everyday patient with AF in Europe.

The AF pilot database does not include any other profile or site questionnaire which can help us explain the observed difference in used protocols for AF ablation in different regions.

As there was no predefined follow-up strategy, there is a risk of underreporting due to less dense follow-up or follow-up performed by physicians different from the one performing the ablation, or different rules for reporting adverse events in participating centres.

The AF pilot database contains data regarding the median number of AF ablations performed per year. This is the only data available, which can be used to anticipate the centres' experience level and is obviously a limitation for the study.

Conclusion

The current analysis of data from the AF Ablation Pilot Registry with all-comer patients shows that patient selection for AF ablation follows current guidelines. The study reveals significant differences in co-morbidity level, medication, ablation strategy, and follow-up procedures. Despite the fact that ablation strategy exhibits differences between regions, 1-year outcomes remain without significant differences and are in line with previously published clinical trials.

Supplementary material

Supplementary material is available at *Europace* online.

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Conflict of interest: L.T. is on the speakers bureau for Servier and is a member of trial committees for Servier, Boston Scientific, St Jude Medical, Medtronic, and CVIE Therapeutics. P.V. received small consultancy fees from Bayer, Boehringer Ingelheim, Menarini, Medtronic, and Servier and is a member of the speakers bureau for the companies mentioned above.

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