JAFIB
Original Research
Journal of Atrial Fibrillation

www. jafib.com

Prevalence and Impact of Atrial Fibrillation in a Cohort of Patients with Hypertrophic Cardiomyopathy in Ireland

McClelland S[1], O'Connor SA[1], Donohue S[1], Lavelle L[1], McErlean A[1], Dodd JD[1], Meaney J[1], McCreery CJ[1], McDonald K[1], Quinn M[1], Erwin JE[1], Quigley PJ[1], Maurer B[1], Keane D[1]

[1]St. Vincent's University Hospital, Elm Park, Dublin 4, Ireland

Abstract

Aims: Atrial fibrillation (AF) is the most common sustained arrhythmia in patients with hypertrophic cardiomyopathy (HCM), and is associated with deterioration in clinical status and outcome. To date, no data have been published pertaining to AF in an Irish HCM population.

Methods and Results: 159 patients with HCM attending St Vincent's University Hospital and Blackrock Clinic, Dublin, were identified. Detailed review of medical notes, Holter monitor, echocardiogram, cardiac MRI (CMR) and implantable cardioverter-defibrillator (ICD) records was performed.

Prevalence of AF was 38.4%. HCM patients with AF (HCM-AF) were older(60.6±14.8v54.9±17.3 years, P=0.016) and more symptomatic (NYHA II: 29.7%v16.9%, NYHA III: 4.3%v 1.2%) than HCM patients without AF. History of stroke was recorded in 16.4% of HCM-AF patients, compared with 1% in those without AF.

HCM-AF patients had lower left ventricular ejection fraction (echo: 59.5±11.8v68±8, P<0.001; CMR:62.3%v70.5%, P<0.01) and higher left atrial diameter (echo: 49.8±9.5v40.9±7.4, p<0.001; CMR62.3±11.3v70.4±9, p<0.001), compared with those without AF.Myocardial fibrosiswas detected on CMR in 74% of HCM-AF patients and 62% of those without AF.

34% of patients had an ICD in situ, of whom 61% had AF. 24% of these HCM-AF patients received inappropriate shocks, all triggered by AF.

Conclusion: AF is common in the Irish HCM population. It is associated with increased risk of stroke, deterioration in symptom status and is a common trigger for inappropriate ICD discharge. We have shown, in-keeping with previous studies, that AF is associated with reduced EF, increased LA diameter and mitral regurgitation in this HCM population.

Introduction

Hypertrophic cardiomyopathy (HCM) is the most common inherited cardiovascular disorder, with a reported prevalence of 1 in 500 in the general population[1], and is a leading cause of sudden death in young people[2,1,3]. HCM is characterised by significant heterogeneity in terms of causative genetic mutations and phenotypic expression. Consequently, HCM populations internationally may differ significantly in terms of their clinical characteristics and outcomes. In Ireland, HCM was the most common cause of sudden cardiac death (SCD) in patients younger than 25 years in the 10 years between 1993 and 2002[4] and the third most common cause of SCD in patients aged between 15 and 35 years, from 2005 to 2007[5].

Key Words

Hypertrophic Cardiomyopathy, Atrial fibrillation, Left Atrium, Cardiac MRI

Corresponding Author
Sarah McClelland,
St. Vincent's University Healthcare Group, Dublin, Ireland

Atrial fibrillation (AF) is the most common sustained arrhythmia and clinical complication in patients with HCM[6], and its development is characterised by deterioration in clinical status, functional capacity, quality of life and outcome[1,7-9]. The unfavourable prognosis in HCM patients with AF is secondary to the resultant increased risk of heart failure-related mortality, thromboembolism, and severe functional impairment[10].AF has been reported to be present in approximately 5% of HCM patients at the time of diagnosis, with an annual incidence of 2% per year, almost 5-times that of the general population[8]. Indeed, the true annual incidence of AF may be higher, with a recentstudy demonstrating a 7% annual incidence of device-detected AF in patients with implantable cardiac devices[11] A number of factors have been identified that predict susceptibility to AF in the HCM population. These include advancing age[12], left atrial enlargement[1,13,14], mitral regurgitation severity, and the presence and extent of myocardial fibrosis[13,15]. however not all studies have concurred.

The overall prevalence of AF in HCM patientshas been reported to be 22%[16], from systematic review of the literature, however, the prevalence within reported populations internationally varies widely,

ranging from 18-35%[16]. This is unsurprising given the marked genetic and phenotypic heterogeneity that characterises HCM. For this reason, it is important to determine local characteristics of HCM populations, to identify areas for risk reduction and therapeutic intervention.

To date, no data has been published relating to AF in a HCM population in Ireland. Here, we report on the clinical and imaging characteristics of a cohort of HCM patients in Ireland, as well as the prevalence and impact of AF in this Irish HCM population.

Methods

Patient Identification

A cohort of 159 adult patients with HCM attending St Vincent's University Hospital, and Blackrock Clinic, Dublin, was identified via electronic radiology and echocardiography reports, clinical letters, and chart review.

Clinical Evaluation

Clinical information pertaining to symptom status, family history, risk factors for SCD and current medications was collected by detailed review of medical notes and out-patient letters. Information on the presence or absence of AF, sustained or non-sustained ventricular tachycardia, or other arrhythmia, was obtained by review of Holter monitor reports, medical notes, ECGs, and pacemaker/ICD interrogation reports. The occurrence of appropriate or inappropriate ICD discharge was established based on ICD interrogation reports and review of medical notes.

Imaging characteristics were obtained from transthoracic echocardiogram (TTE) and cardiac MRI (CMR) reports.

Details were recorded at a single time-point for each patient, reflecting the most recent clinical and imaging details at the time of investigation. In those cases where clinical or imaging data were incomplete, these patients were omitted from analysis of the affected parameters.

Echocardiography

Echocardiographic measurements were made on TTE in the standard views, as per the European Society of Echocardiography guidelines. Left ventricular hypertrophy was assessed on TTE in the parasternal short-axis view at end diastole, at the mitral valve and papillary muscle levels. Left ventricular end-diastolic diameter (LVEDD) and end-systolic diameter (LVESD) were measured from parasternal long-axis views. The left ventricular outflow tract (LVOT) gradient was calculated from continuous-wave Doppler using the simplified Bernoulli equation.

Cardiac MRI

All subjects were examined on a 1.5 Tesla magnet (Avanto, Siemens, Erlangen, Germany) using an eight-element phased-array cardiac coil for signal reception. Left and right ventricular function was obtained with single slice cine images using a steady-state free precession (SSFP) technique (repetition time, 3.5msec; echo time, 1.4msec; matrix, 192x192; field of view, 34x34 cm; slice thickness 6mm, slice gap 1mm) obtained in two-chamber, four-chamber and short axis planes

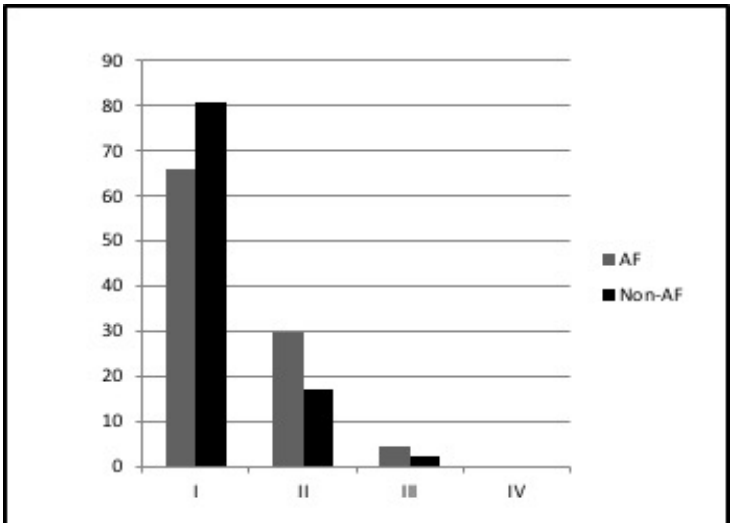

Figure 1: **Symptom status in HCM patients with and without atrial fibrillation**

LA, left atrial; LV, left ventricular; MV, mitral valve; TTE transthoracic echocardiogram; MRI, magnetic resonance imaging;
LVOT, left ventricular outflow tract.

to include the entire ventricle from base to apex. These were followed by a bolus injection of 0.2 mmol/Kg of hand-injected gadopentetate dimeglumine (Gd-DTPA - Schering AG, Berlin, Germany). Between 10 -12 minutes later, LE CMR was obtained by using single slice double inversion-recovery prepared gated fast-gradient echo pulse sequences. Late enhancement images were acquired to optimally show normal myocardium/trabeculae (dark) and regions of LE within myocardium (bright) with proper selection of the inversion time (TI). Imaging parameters were as follows: TR 7.1ms; TE 3.1ms; image matrix 256x192; flip angle 20o; inversion pulse 180o; slice thickness 7, slice gap 1mm, and TI between 150 and 300ms.

Data Analysis

Data are expressed as mean +/- standard deviation or frequency (percentage), as appropriate. Differences in continuous variables with normal distribution were assessed using the two-sample t-test. Categorical variables are expressed as percentages and were compared using the Fisher's exact test. Statistical significance was defined by $P<=0.05$.

Ethical Approval

Approval was granted from the clinical research and audit committee, St. Vincent's University Hospital.

Results

Patient demographics

A total of 159 patients with HCM were identified for whom rhythm and imaging data were available. Of these, 99 (62.3%) were male. The median age was 59 years, with a range from 17-90 years. There was a documented family history of HCM in 30.2% of cases. (Table. 1).

Clinical Characteristics at Registration

The clinical characteristics and risk factors for SCD in the HCM population are listed in Table 1. 27.7% of patients were known to have

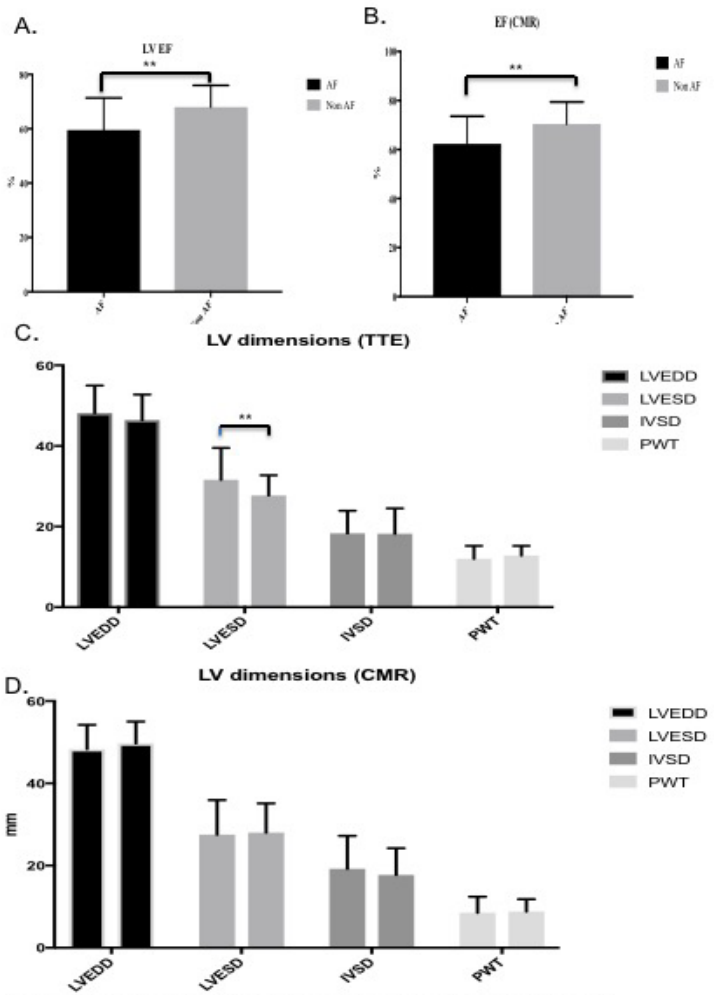

Figure 2: **Imaging characteristics of HCM patients with and without atrial fibrillation.**

A. Assessment of LVEF by TTE; B. Assessment of LVEF by CMR; C. Comparison of chamber dimension and LV wall thickness assessed by TTE; D. Comparison of chamber dimension and LV wall thickness assessed by CMR. **p<0.001
HCM, hypertrophic cardiomyopathy; LVEF, left ventricular ejection fraction; CMR, cardiac MRI; TTE, transthoracic echocardiogram; LVEDD, left ventricular end diastolic dimension; LVESD, left ventricular end systolic dimension; IVSD, interventricular septal dimension; PWT, posterior wall thickness.

had one or more episodes of sustained or non-sustained ventricular tachycardia. 11.3% had one or more episodes of syncope, while a family history of SCD was present in 20.8% of cases. Eight patients (5%) had LVwall thickness of >30mm. Of the 73 patients with exercise stress test results documented, 9 (12.3%) had a hypotensive response to exercise. One patient (0.6%) had survived a previous cardiac arrest.

Prevalence and complications of Atrial Fibrillation

Atrial fibrillation was documented in 61 patients (38.4%) in this HCM population. Patients with documented AF were significantly older than those without AF (mean age 60.6 +/-14.8 v 54.9+/-17.3 years, P=0.016), and there was a male preponderance in the AF group (63.9%). 28% of the HCM patients with AF were aged 50 years or younger.

New York Heart Association (NYHA) functional class was documented for 131 patients (47 AF, 83 non-AF). Patients with AF were more likely to be symptomatic than those HCM patients in sinus rhythm. The proportion of patients reporting NYHA I symptoms was significantly higher in HCM patients without AF, compared with those with AF (80.7% vs 64.6%, p<0.05) , with 29.8% and 4.2% of AF patients in NYHA Class II or III, respectively, compared 16.9% and 1.2% of patients without AF. (Figure 1).

The overall prevalence of thromboembolism in HCM patients with AF in published cohorts is 27%, with a range from 19-58%(16). In this HCM cohort, a total of 17 patients were documented to have experienced CVA and/or TIA. CVA occurred in 11 patients (6.9%), and transient ischaemic attack (TIA) occurred in 10 patients (6.3%). 91% of the patients who experienced CVA, and 70% of the patients with previous TIA had documented AF. Stroke had occurred in 18% of HCM patients with AF in this cohort. The overall prevalence of CVA/TIA in this HCM-AF cohort was 27.8%. (Table 1).

Medications in use at the time of index review were known for 145 patients (Table 1). The most frequently used medications were beta-blockers (70.3%), statins (66.2%) and antiplatelet agents (33.7%). 39 patients with AF (67.3%) were taking an oral anticoagulant (OAC) at the time of index review which was significantly lower than expected, while a further 2 patients with AF had stopped OAC due to bleeding complications.

Imaging Characteristics in HCM patients with and without AF

All patients had baseline imaging performed by means of standard transthoracic echocardiography (TTE, n=152) or cardiac MRI (CMR, n=109), or both. Imaging characteristics were recorded for each patient, and are presented in Table 2.

HCM tends to be a hyperdynamic state, usually resulting in supra-normal left ventricular ejection fraction (LVEF). In the HCM group as a whole, the average LVEF measured on TTE was 64.6±10.5%, and measured by CMR was 69.9+-10.5%. There was a statistically significant reduction in LVEF in HCM patients with AF compared with those in sinus rhythm, as measured by TTE (59.5±11.8% vs 68±8%, P<0.001) and CMR (62.3±11.3% vs 70.4±9%, p<0.001) (Table 2 and Figure 2).

Left atrial (LA) diameter was measured by TTE and CMR. In the group as a whole, the average LA diameter was 44.3±9.4mm, measured by TTE, and 37.6±8mm measured by CMR. As expected, LA diameter was significantly increased in HCM patients with AF compared with those without AF, as assessed by TTE (49.3+/-9.5mm vs 40.9+/-7.4mm, P<0.001) and CMR (42.7+/-9.4mm vs 35.3+/-6.5mm, P<0.001). 61.2% of patients with AF had moderately or severely dilated LA on TTE, while moderate to severe LA dilatation was present in 22.8% of HCM patients without AF(p<0.0001).

Left ventricular end diastolic dimension (LVEDD) and left ventricular end systolic dimension (LVESD), as assessed by TTE, in the HCM group as a whole were 47±6.6mm and 29.2±6.5mm, respectively. There was a trend towards larger LVEDD in the AF group that did not reach statistical significance (48.1+/-6.8mm vs 46.4+/-6.6mm, p=0.08), and there was a significant increase in LVESD in the AF group compared with those without AF (31.6+/-7.9 vs 27.7+/-5mm, p<0.001), as measured by TTE, which may reflect the progression

Table 1: Clinical characteristics of HCM patients with and without AF at index review.

	All patients (n=159)	Patients with AF (n=61)	Patients without AF (98)	P-Value
Age at registration, years (mean, range)	59 (17-90)	61 (21-90)	57.5 (17-90)	0.016
Gender: male (%)	99 (62.3%)	39 (63.9%)	60 (60.6%)	0.738
Family history HCM	48 (30.2%)	14 (23%)	34 (34.7%)	0.155
Atrial fibrillation	61 (38.4%)			
Risk factors for SCD				
NSVT	44 (27.7%)	23 (37.7%)	21 (21.4%)	0.74
Syncope	18 (11.3%)	10 (16.4%)	8 (8.1%)	0.128
Family history SCD	33 (20.8%)	10 (16.4%)	23 (23.5%)	0.32
LV>30mm	8 (5%)			
Hypotensive response to exercise (n=73)	9 (12.3%)	3 (15.8%, n=19)	6 (11.1%, n=54)	0.688
Aborted SCD	1 (0.6%)	1 (1.6%)	0	0.384
LVOT grad >30mmHg	29 (18.2%)	11 (18%)	18 (18.4%)	1.0
Symptoms at index review	(n=143)	(n=53)	(n=90)	
Chest Pain	23(16.1%)	5 (9.4%)	18 (20%)	0.11
Palpitations	36 (25.2%)	19 (35.8%)	17 (18.9%)	0.03
Pre-syncope	13 (9.1%)	4 (7.5%)	9 (10%)	0.77
NYHA Class	(n=131)	(n=48)	(n=83)	
I	99 (75.6%)	31 (64.6%)	67 (80.7%)	0.036
II	28 (21.4%)	14(29.2%)	14 (16.9%)	0.12
III	4 (3.1%)	3 (4.2%)	1 (1.2%)	0.14
IV	0	0	0	
History of stroke	11 (6.9%)	10 (16.4%)	1 (1.0%)	0.0003
History of TIA	10 (6.3%)	7 (11.5%)	3 (3,1%)	0.044
ICD implantation	54 (33.9%)	33 (54.1%)	21 (21.4%)	0.0001
Appropriate ICD shock(s)	4	2 (6.1%)	2 (9.5%)	0.64
Inappropriate ICD shock(s)	11	8 (24.2%)	3 (14.3%)	0.49
Medications	(n=145)	(n=58)	(n=87)	
Beta-blocker	102 (70.3%)	41 (70.7%)	61 (70.1%)	0.61
Statin	96 (66.2%)	24 (41.4%)	51 (58.6%)	0.14
Aspirin	44 (30.3%)	16 (27.6%)	28 (32.2%)	0.56
ACE/ARB	40 (27.6%)	17 (29.3%)	23 (26.4%)	0.58
CCB	31 (21.4%)	15 (25.9%)	16 (18.4%)	0.22
OAC	40 (27.6%)	39 (67.2%)	1 (1.1%)	0.0001
Sotalol	13 (9%)	9 (15.5%)	4 (4.6%)	0.07
Amiodarone	10 (6.9%)	8 (13.8%)	2 (2.3%)	0.007
Frusemide	10 (6.9%)	6 (10.3%)	4 (4.6%)	0.18
Clopidogrel	5 (3.4%)	1 (1.7%)	4 (4.6%)	0.65
Digoxin	3 (2.1%)	3 (5.2%)	0	0.05

HCM, hypertrophic cardiomyopathy; SCD, sudden cardiac death; NSVT, non-sustained ventricular tachycardia; NYHA, New York heart association); TIA, transient ischaemic attack; ICD, implantable cardioverter defibrillator; ACE, angiotensin converting enzyme; ARB, angiotensin receptor blocker; CCB, calcium channel blocker; OAC, oral anticoagulant

towards the dilated phase in those HCM patients with AF. However, this change in LV dimensions was not observed in those patients who underwent CMR (LVEDD 48.3+/-5.8mm vs 49.2+/-6mm, P=0.3; LVESD 27.5+/-8.4mm vs 28.1+/-7.7mm, P=0.3). (Figure 2). This may be explained by the use of TTE as primary imaging modality in patients with implantable cardiac devices in situ.

The overall maximal LV wall thickness in the HCM cohort was measured by TTE at 18.2±6mm, and at 18.1±6.1mm by CMR. There was no significant difference in the degree of septal hypertrophy in the AF group compared with those patients without AF, as measured by TTE or CMR (18.3±05.6mm vs 18.2±6.3mm, p=0.46; and 19.2±4.8mm vs 17.5±6.5mm, p=0.16). (Figure 2)

Myocardial fibrosis was detected in 66% (72 patients) of the HCM patients who underwent CMR in this cohort (n=109). There was a higher prevalence of myocardial fibrosis in HCM population with AF than those without AF (73.7% vs 61.9%), however this did not reach statistical significance. Similarly, there was no significant difference in the severity of LGE between the two groups.

Table 2: Imaging characteristics in HCM patients as assessed by echocardiography and cardiac MRI

	All patients	Patients with AF	Patients without AF	P-Value
EchocardiographicCharacteristics (n=152))		(n=57)	(N=95)	
Ejection Fraction (%)	64.6±10.5	59.5±11.8	68±8	<0.001
LA diameter, mm	44.3±9.3	49.8±9.5	40.9±7.4	<0.001
LV end-diastolic dimension, mm	47±6.6	48.1±6.8	46.4±6.3	0.08
LV end-systolic dimension, mm	29.2±6.5	31.63±7.9	27.7±5	<0.001
Interventricular septal diameter, mm	18.2±6	18.3±5.6	18.2±6.3	0.46
Posterior Wall Thickness, mm	12.5±2.8	12±3.3	12.8±2.5	0.14
Systolic Anterior Motion of MV (TTE or MRI)	26.7%	15 (n=61) (24.5%)	29 of 98 (29.6%)	0.59
LVOT > 30mmHg	29 (18.2%)	11 (18%)	18 (18.4%)	1.0
Moderate to severe MR (TTE or MRI)	19 (11.9%)	12 (19.7%)	7 (7.1%)	<0.0001
Cardiac MRI Characteristics (n=93)				
Ejection Fraction (%)	69.9+/-10.4	62.3±11.3	70.4±9	<0.001
Max Thickness, mm	18.2±6	19.7±1.07	19.48±0.85	0.17
LA diameter, mm	37.8±8	42.7±9.4	35.3±6.5	<0.001
End diastolic dimension, mm	49.41±5.5	48.3±5.9	49.8±5.3	0.17
End systolic dimension, mm	27.83±7.4	27.5±8.4	28±7.1	0.41
Anterior septal wall thickness, mm	18.1±6	19.2±4.8	17.7±6.5	0.17
Posterior septal wall thickness, mm	8.8±3.2	8.6±3.9	8.8±3	0.37
Late Gadolinium Enhancement (%)	72 (n=109,66%)	28 (n=38, 73.7%)	44(n=71, 62%)	0.29

LA, left atrial; LV, left ventricular; MV, mitral valve; TTE transthoracic echocardiogram; MRI, magnetic resonance imaging;
LVOT, left ventricular outflow tract.

ICD Discharge Events

54 (33.5%) of the HCM patients studied had an ICD in situ, 61% of whom had AF. Of those HCM-AF patientswithICDs in situ, 24% received inappropriate shocks, all of which were triggered by AF, while 9.1% received appropriate ICD shocks (Table 1).

Discussion

The maintenance of sinus rhythm is crucial for the functional capacity of patients with HCM[17]. AF is the most common sustained arrhythmia affecting patients with HCM. Its development is associated with clinical and functional deterioration,as well as increased risk of embolic stroke and heart-failure progression[18]. While AF is not an independent determinant of SCD, there is a 3-fold increase in the risk of HCM-related deaths in AF patients compared with that in matched controls in sinus rhythm[8]. There is significant heterogeneity within HCM populations, in terms of genetic and phenotypic characteristics. Unsurprisingly, therefore, the prevalence of AF in internationally reported cohorts has varied widely[16]. Determination of the local characteristics of HCM populations is important, therefore, in order to identify areas for risk reduction and opportunities for therapeutic intervention. Herein we have determined the prevalence of AF in an Irish HCM population to be 38%. This is a relatively high proportion compared with international studies, however, it is similar to that reported in the UK (30%)[6]. The high prevalence of AF in this HCM population underscores the necessity for close monitoring and early pharmacological intervention to minimise embolic complications in our HCM population.

The Irish population has been shown to be genetically homogeneous. [28,29], which is reflected the higher frequencies of several traits, including cystic fibrosis, galactosaemia, multpiple sclerosis, and lactase deficiency, compared to those of mainland Europe [29]. This genetic homogeneity lends itself well to the study of inherited diseases, and may in part underlie the relatively higher incidence of atrial fibrillation in this cohort, compared with other published cohorts. Conversely, however, these findings may not be directly applicable to poplulations with wider genetic diversity, such as that of the United States of America.

In this cohort, HCM patients with AF were significantly older than those without documented AF, in keeping with previous studies[12]. Unsurprisingly, the presence of AF is correlated with increasing symptom severity, with fewer HCM-AF patients reporting NYHA class I symptoms than those without documented AF. This finding is in-keeping with those of other large HCM cohorts[19,] and underscores the link between the development of AF and deterioration of functional status.

HCM patients with AF have been shown to have an 8-fold increase in the risk of ischaemic stroke compared with that of HCM patients in sinus rhythm.[8] The prevalence of cardioembolic complications in our HCM-AF population (27.9%) was very similar to the overall prevalence reported by Guttmann et al. (27%)[16]. While all but one stroke occurred in patients with known AF, 30% of those experiencing a TIA did not have documented AF. This raises the important question as to whether these patients are experiencing undiagnosed paroxysmal AF, and warrant more frequent or more lengthy rhythm monitoring.

There are currently no randomised controlled clinical trials addressing the use of anticoagulation in HCM patients, and the CHA_2DS_2-VASc score is not validated in this patient group. However, the relatively high rate of cardioembolic complications in HCM patients with AF has led to the general consensus that all patients with HCM and paroxysmal or persistent AF be anticoagulated[20,21], even following the restoration of sinus rhythm. 70.6% of patients in this HCM-AF population had a history of OAC use, while 67% of HCM-AF patients were anticoagulated at the time of data recording. This was a lower proportion of patients than expected, and warrants further investigation.

HCM is a hyper dynamic state, with frequently supra-normal left ventricular ejection fraction (EF) demonstrated. In this cohort, left ventricular function was significantly reduced in the HCM-AF group, compared to those patients in sinus rhythm, as measured by echocardiography and CMR, in keeping with the findings in other international HCM-AF cohorts[19].

Left atrial (LA) size, volume and function have been shown to be determinants of AF in HCM patients[8,13,17,22]. It has been suggested that the strong relationship between LA dilatation and AF in HCM patients may be explained by the electrical and structural remodelling that occur in the process of LA dilatation, including shortening of the atrial effective refractory period and local conduction delay[13]. Indeed, an upper LA size of 4.5cm has been proposed in recent ESC guidelines, beyond which more frequent rhythm monitoring should be performed due to the increased risk of developing AF[21].Here, we have confirmed the association of LA size with AF in this Irish HCM population. As expected, LA diameter was significantly increased in our HCM patients with AF compared with those without AF, as assessed by echocardiography and CMR. The severity of mitral regurgitation has also been shown previously to correlate with the presence of AF in HCM patients. This association is also reflected in the data from this cohort, where moderate to severe MR was present in 19.7% of HCM patients with AF, compared with 7.1% of those without documented AF. Furthermore, in keeping with the observation from numerous international studies that there is no association between outflow tract obstruction and AF[19], we did not observe increased rates of AF in patients with significant outflow tract obstruction.

The presence and extent of myocardial fibrosis, as demonstrated by late gadolinium enhancement (LGE) on CMR has been shown to correlate with poor prognosis in HCM patients[23], and to be independently associated with AF[24,] as well as sustained ventricular tachycardia and appropriate ICD discharges[25] in patients with HCM. LGE is inferior to LA size for predicting AF prevalence, however. It has been suggested that the extent, but not the presence, of myocardial fibrosis is indicative of AF in HCM patients[13], the severity of myocardial fibrosis on CMR has been shown to predict sustained arrhythmic events in HCM patients[25]. In this cohort, there was a higher prevalence of LGE in the HCM-AF group, however this did not reach statistical significance.

Implantable cardioverter defibrillators (ICD) successfully terminate life-threatening arrhythmias in HCM patients at increased risk of

SCD. ICD insertion is indicated in HCM patients with significant or numerous risk factors for SCD, or who have had a resuscitated cardiac arrest(20). In HCM patients with ICDs, end-stage heart failure is the leading cause of mortality(26). Rapidly conducted AF and other SVTs have been shown to account for up to 80% of unnecessary shocks in patients with ICDs(27). 34% of the patients in this HCM population had an ICD in situ. Of those patients for whom ICD interrogation data was available, 27.8% (15 patients) had received an ICD shock, the majority of which were inappropriate (Table 1.).Almost a quarter of of HCM-AF patients with ICDs had received an inappropriate shock(s), all of which were triggered by AF, illustrating a further complication arising from AF in in this HCM cohort.

Study Limitations

While this study is the first on clinical and imaging characteristics in an Irish HCM population, it has a number of limitations. The data for each patient is retrospective and represents a single time point, and does not take into account duration of diagnosis or response to treatment. Furthermore, the data is limited to a clinical history of stroke and it might be postulated that a prospective study of routine brain MRI screening may reveal additional silent ischaemic events. Routine genetic analysis was not performed in this study and thus it is unknown if the relatively high incidence of AF in our study could reflect a unique genetic preponderance in this Irish HCM cohort.

Further prospective studies of outcome, response to definitive AF treatment strategies, prognosis and prognostic factors in patients with AF and HCM are planned.

Conclusion

We have demonstrated that AF is common in the Irish HCM population, with a prevalence of 38.4%. It is associated with increased risk of stroke, deterioration in symptom status and inappropriate ICD discharge. We have also shown, in-keeping with international registries, that AF is associated with reduced EF, increased LA diameter and mitral regurgitation, in an Irish HCM population.

References

1. Maron BJ, Olivotto I, Bellone P, Conte MR, Cecchi F, Flygenring BP, et al. Clinical profile of stroke in 900 patients with hypertrophic cardiomyopathy. J Am Coll Cardiol. 2002;39(2):301-7.
2. Maron BJ, Olivotto I, Spirito P, Casey SA, Bellone P, Gohman TE, et al. Epidemiology of hypertrophic cardiomyopathy-related death: revisited in a large non-referral-based patient population. Circulation. 2000;102(8):858-64.
3. Maron BJ, McKenna WJ, Danielson GK, Kappenberger LJ, Kuhn HJ, Seidman CE, et al. American College of Cardiology/European Society of Cardiology clinical expert consensus document on hypertrophic cardiomyopathy. A report of the American College of Cardiology Foundation Task Force on Clinical Expert Consensus Documents and the European Society of Cardiology Committee for Practice Guidelines. J Am Coll Cardiol. 2003;42(9):1687-713.
4. Quigley F, Greene M, O'Connor D, Kelly F. A survey of the causes of sudden cardiac death in the under 35-year-age group. Ir Med J. 2005;98(8):232-5.
5. Margey R, Roy A, Tobin S, O'Keane CJ, McGorrian C, Morris V, et al. Sudden cardiac death in 14- to 35-year olds in Ireland from 2005 to 2007: a retrospective registry. Europace. 2011;13(10):1411-8.
6. Robinson K, Frenneaux MP, Stockins B, Karatasakis G, Poloniecki JD, McKenna WJ. Atrial fibrillation in hypertrophic cardiomyopathy: a longitudinal study. J Am Coll Cardiol. 1990;15(6):1279-85.
7. Cecchi F, Olivotto I, Betocchi S, Rapezzi C, Conte MR, Sinagra G, et al. The Italian Registry for hypertrophic cardiomyopathy: a nationwide survey. Am Heart J. 2005;150(5):947-54.
8. Olivotto I, Cecchi F, Casey SA, Dolara A, Traverse JH, Maron BJ. Impact of atrial fibrillation on the clinical course of hypertrophic cardiomyopathy. Circulation. 2001;104(21):2517-24.
9. Cecchi F, Olivotto I, Montereggi A, Santoro G, Dolara A, Maron BJ. Hypertrophic cardiomyopathy in Tuscany: clinical course and outcome in an unselected regional population. J Am Coll Cardiol. 1995;26(6):1529-36.
10. Guttmann OP, Pavlou M, O'Mahony C, Monserrat L, Anastasakis A, Rapezzi C, et al. Predictors of atrial fibrillation in hypertrophic cardiomyopathy. Heart. 2017;103(9):672-8.
11. van Velzen HG, Theuns DA, Yap SC, Michels M, Schinkel AF. Incidence of Device-Detected Atrial Fibrillation and Long-Term Outcomes in Patients With Hypertrophic Cardiomyopathy. Am J Cardiol. 2017;119(1):100-5.
12. Maron BJ, Ommen SR, Semsarian C, Spirito P, Olivotto I, Maron MS. Hypertrophic cardiomyopathy: present and future, with translation into contemporary cardiovascular medicine. J Am Coll Cardiol. 2014;64(1):83-99.
13. Papavassiliu T, Germans T, Flüchter S, Doesch C, Suriyakamar A, Haghi D, et al. CMR findings in patients with hypertrophic cardiomyopathy and atrial fibrillation. J Cardiovasc Magn Reson. 2009;11:34.
14. Tani T, Yagi T, Kitai T, Kim K, Nakamura H, Konda T, et al. Left atrial volume predicts adverse cardiac and cerebrovascular events in patients with hypertrophic cardiomyopathy. Cardiovasc Ultrasound. 2011;9:34.
15. Yamaji K, Fujimoto S, Yutani C, Ikeda Y, Mizuno R, Hashimoto T, et al. Does the progression of myocardial fibrosis lead to atrial fibrillation in patients with hypertrophic cardiomyopathy? Cardiovasc Pathol. 2001;10(6):297-303.
16. Guttmann OP, Rahman MS, O'Mahony C, Anastasakis A, Elliott PM. Atrial fibrillation and thromboembolism in patients with hypertrophic cardiomyopathy: systematic review. Heart. 2014;100(6):465-72.
17. Girasis C, Vassilikos V, Efthimiadis GK, Papadopoulou SL, Dakos G, Dalamaga EG, et al. Patients with hypertrophic cardiomyopathy at risk for paroxysmal atrial fibrillation: advanced echocardiographic evaluation of the left atrium combined with non-invasive P-wave analysis. Eur Heart J Cardiovasc Imaging. 2013;14(5):425-34.
18. Higashikawa M, Nakamura Y, Yoshida M, Kinoshita M. Incidence of ischemic strokes in hypertrophic cardiomyopathy is markedly increased if complicated by atrial fibrillation. Jpn Circ J. 1997;61(8):673-81.
19. Kubo T, Kitaoka H, Okawa M, Hirota T, Hayato K, Yamasaki N, et al. Clinical impact of atrial fibrillation in patients with hypertrophic cardiomyopathy. Results from Kochi RYOMA Study. Circ J. 2009;73(9):1599-605.
20. Fuster V, Rydén LE, Cannom DS, Crijns HJ, Curtis AB, Ellenbogen KA, et al. 2011 ACCF/AHA/HRS focused updates incorporated into the ACC/AHA/ESC 2006 guidelines for the management of patients with atrial fibrillation: a report of the American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines. Circulation. 2011;123(10):e269-367.
21. Elliott PM, Anastasakis A, Borger MA, Borggrefe M, Cecchi F, Charron P, et al. 2014 ESC Guidelines on diagnosis and management of hypertrophic cardiomyopathy: the Task Force for the Diagnosis and Management of Hypertrophic Cardiomyopathy of the European Society of Cardiology (ESC). Eur Heart J. 2014;35(39):2733-79.
22. Losi MA, Betocchi S, Aversa M, Lombardi R, Miranda M, D'Alessandro G, et al. Determinants of atrial fibrillation development in patients with hypertrophic cardiomyopathy. Am J Cardiol. 2004;94(7):895-900.
23. O'Hanlon R, Grasso A, Roughton M, Moon JC, Clark S, Wage R, et al. Prognostic significance of myocardial fibrosis in hypertrophic cardiomyopathy. J Am Coll Cardiol. 2010;56(11):867-74.
24. Pujadas S, Vidal-Perez R, Hidalgo A, Leta R, Carreras F, Barros A, et al. Correlation between myocardial fibrosis and the occurrence of atrial fibrillation in hypertrophic

cardiomyopathy: a cardiac magnetic resonance imaging study. Eur J Radiol. 2010;75(2):e88-91.

25. Prinz C, Schwarz M, Ilic I, Laser KT, Lehmann R, Prinz EM, et al. Myocardial fibrosis severity on cardiac magnetic resonance imaging predicts sustained arrhythmic events in hypertrophic cardiomyopathy. Can J Cardiol. 2013;29(3):358-63.
26. Magnusson P, Gadler F, Liv P, Mörner S. Causes of death and mortality in hypertrophic cardiomyopathy patients with implantable defibrillators in Sweden. J Cardiovasc Med (Hagerstown). 2016;17(7):478-84.
27. Daubert JP, Zareba W, Cannom DS, McNitt S, Rosero SZ, Wang P, et al. Inappropriate implantable cardioverter-defibrillator shocks in MADIT II: frequency, mechanisms, predictors, and survival impact. J Am Coll Cardiol. 2008;51(14):1357-65.