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Catheter ablation for atrial flutter: a survey by the European Heart Rhythm Association and Canadian Heart Rhythm Society

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The purpose of this EP wire survey was to examine current practice in the management of both cavotricuspid isthmus (CTI)-dependent and non-CTI-dependent atrial flutter (AFL) ablation amongst electrophysiologists in European and Canadian centres and to understand how current opinions vary from guidelines. The results of the survey were collected from a detailed questionnaire that was created by the European Heart Rhythm Association Research Network and the Canadian Heart Rhythm Society. Responses were received from 89 centres in 12 countries. This questionnaire highlights variability within certain aspects of the management of AFL ablation. The variability in opinion regarding other procedural details suggests a need for further research in this area and consideration of the development of guidelines specific to AFL. Overall, there is reasonable consensus regarding oral anticoagulation and the desired endpoints of ablation for patients with CTI-dependent AFL and for non-CTI-AFL.

Keywords EP wire • Atrial flutter • Catheter ablation • Anticoagulation • Periprocedural management • EHRA survey

Introduction

Typical atrial flutter (AFL) is categorized as either typical counter-clockwise AFL when the macro re-entrant circuit is dependent on the cavotricuspid isthmus (CTI) and uses this isthmus from the patients right to left or typical clockwise AFL when the macro re-entrant circuit is dependent on the CTI and uses this isthmus from the patient's left to right. Atypical AFL is not dependent on the CTI and may be either macro re-entrant as in peri-mitral, left atrial roof dependent or scar related (from prior ablation or surgery) atypical AFL or micro re-entrant (≤2 cm in diameter) AFL, which often resemble a focal atrial tachycardias.[1] Catheter ablation for the management of CTI-dependent AFL is considered to be a highly successful procedure with an acute success of approximately 97%[2] and a recurrence probability of approximately 10% over 14 months.[3] Nevertheless, the subsequent occurrence of atrial fibrillation (AF) is common following a catheter ablation for CTI-dependent AFL with reported incidences of 34% to 53% over 14 months[2] and up to 82% of patients over 5 years.[4] Catheter ablation for non-CTI dependent AFL is technically more difficult with a large range in reported success rates from 73–100% and reported recurrence probabilities of 7–53% depending on the underlying mechanism for the atypical AFL.[5] As a

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result, for CTI-dependent AFL catheter ablation is considered to be useful in patients with AFL who are either symptomatic or refractory to drug therapy (Class I indication, level of evidence B) and for recurrent symptomatic non-CTI dependent AFL after failure of at least one antiarrhythmic drug (Class I indication, level of evidence C).[5,6] There are several technologies available for this procedure that would likely predict a wide range of variability of clinical practice in the periprocedural and procedural periods. The purpose of this EP wire survey was to examine current practice in European and Canadian centres performing these procedures in order to gain an understanding of real-world experience and to identify deficiencies in practice which may need to be further addressed.

Methods

Results from the survey were collected from a detailed questionnaire that was jointly created by the European Heart Rhythm Association (EHRA) Scientific Initiatives Committee and the Canadian Heart Rhythm Society (CHRS). The questionnaire was sent via the internet to the EHRA-EP Research Network Centres and all registered CHRS members. Responses were examined as pre-procedure, intra-procedure, and post-procedure practices for each of CTI-dependent and non-CTI dependent AFL. Percentages are expressed with the denominator being according to the number of individuals who provided responses to each question. Statistical analysis by Chi-squared test and Fisher's exact test were used to compare responses between Europe and Canada. A P-value ≤ 0.05 was considered to be statistically significant.

Results

Of 89 responses received from centres in 12 countries (59 from Canada and 30 from European countries), 77/89 (86%) were from a university hospital, 4/89 (5%) from a non-academic private hospital, and 8/89 (9%) from a non-academic public or other type of institution; 25/89 responses (28%) were from centres performing more than 500 ablations per year (for all types of arrhythmia), 37/89 responses (42%) were received from centres performing 300–500 ablations annually, 11/89 (12%) from centres performing 200–300 ablations per year, 11/89 responses (12%) were received from centres performing between 100 and 200 ablations per year, and 5/89 (6%) were from centres performing less than 100 procedures per year.

Preprocedural management

Catheter ablation was considered to be a therapeutic option only after at least one electrical cardioversion by 44/88 (50%) of respondents for CTI-dependent AFL and by 65/88 (74%) of respondents for non-CTI dependent AFL. Using ablation as first-line therapy was considered to be an appropriate option by 41/88 (47%) of respondents for CTI-dependent AFL and by 10/88 (11%) of respondents for non-CTI dependent AFL. Failure of antiarrhythmic drug therapy was considered to be the indication for catheter ablation by 3/88 respondents (3%) for CTI-dependent AFL and by 13/88 respondents (15%) for non-CTI dependent AFL. There was no significant difference in practice between Europe and Canada.

The details of peri-procedural management of oral anticoagulant therapy with either vitamin K antagonists (VKAs) or non-vitamin K antagonist oral anticoagulants (NOACs) are summarized in *Table 1* for both CTI-dependent and non-CTI-dependent AFL. For patients with CTI-dependent, AFL oral anticoagulation was routinely prescribed for ≥ 3 weeks prior to catheter ablation by 42/89 respondents (47%) and for ≥ 4 weeks before ablation by 28/89 respondents (31%). For patients with non-CTI-dependent AFL, pre-procedural oral anticoagulation was routinely provided for ≥ 3 weeks by 43/89 respondents (48%) and for ≥ 4 weeks by 33/89 respondents (38%). Of the remaining respondents who did not routinely prescribe oral anticoagulation prior to catheter ablation for CTI-dependent and non-CTI dependent AFL 14/89 (16%) and 11/89 (12%), respectively, only prescribed an oral anticoagulant for patients with a CHA_2DS_2-VAS_C score of ≥ 2, irrespective of whether the patient was in AFL or sinus rhythm. The remaining 5/89 (6%) and 2/89 respondents (2%) did not prescribe oral anticoagulant therapy in patients with CTI-dependent and non-CTI-dependent AFL, respectively.

If a patient was on a VKA, 78/89 (87%) and 69/89 (78%) of respondents continued this treatment through the procedure for CTI-dependent and non-CTI dependent AFL, respectively. The remaining respondents either used low molecular weight heparin bridging or held the VKA with no bridging. For patients who were on a NOAC, administration was continued through the procedure by 31/89 (35%) and 19/89 (21%) of respondents for patients with CTI–dependent and non-CTI-dependent AFL, respectively. Of those who discontinued the NOAC prior to catheter ablation for CTI-dependent AFL, NOACs were held for 24 h by 48/89 respondents (54%) and for 48 h by 7/89 respondents (8%). For non-CTI-dependent AFL, NOAC's were held for 24 h by 53/89 respondents (60%) and for 48 h by 11/89 respondents (12%). The remaining responses varied depending on the patient's CHA_2DS_2-VAS_C score or creatinine clearance, for both CTI-dependent and non-CTI-dependent AFL. There were no significant differences in the use of oral anticoagulation between respondents from Europe and Canada apart from a greater continuation of NOAC use throughout the catheter ablation of CTI-dependent AFL in Europe (16/30 respondents, 53%) vs. 15/59 respondents (25%) in Canada, $P = 0.0009$.

Transesophageal echocardiography (TEE) was routinely performed by 15/88 respondents (17%) for CTI-dependent and by 41/88 respondents (47%) for non-CTI dependent AFL prior to or during a catheter ablation. Of those who did not routinely perform a TEE prior to a catheter ablation for typical CTI-dependent AFL 69/88 respondents (78%) only performed a TEE if the patient was in AFL prior to catheter ablation, if the NOAC had been held for ≥ 24 h prior to the procedure or if the international normalized ratio (INR) was subtherapeutic in the 3 weeks before ablation for patients on a VKA. The remaining 4/88 respondents (5%) only performed a TEE in patients with a CHA_2DS_2-VAS_C score of ≥ 2. Of the respondents who did not routinely perform a pre-procedure TEE for non-CTI dependent AFL, 40/88 (45%) only performed a TEE if the patient was in AFL prior to catheter ablation, if the NOAC had been held for at least 24 h prior to the procedure or if the INR was below the therapeutic range during the 3 weeks prior to ablation for patients on a VKA. The remaining 5/88 respondents (6%) performed a TEE only in patients with a CHA_2DS_2-VAS_C score ≥ 2. Two of the 88 respondents (2%) performed a pre-procedural CT to rule out the left atrial appendage

Table 1 Management of periprocedural anticoagulation for CTI-dependent and non-CTI-dependent AFL ablation

	CTI dependent*N* = 89	Non-CTI dependent*N* = 89
Pre-procedural oral anticoagulant use		
Not routinely used	5/89 (6%)	2/89 (2%)
≥3 weeks only for high-risk patients ($CHADS_2$-VAS_C ≥2)	14/89 (16%)	11/89 (12%)
≥3 weeks routinely	42/89 (47%)	43/89 (48%)
≥4 weeks routinely	28/89 (31%)	33/89 (38%)
Procedural VKA use		
Not discontinued	78/89 (87%)	69/89 (78%)
Discontinued OAC and LMWH bridging	7/89 (8%)	14/89 (15%)
Other strategy	4/89 (5%)	6/89 (7%)
Procedural NOAC use		
Continue throughout the ablation procedure	31/89 (35%)	19/89 (21%)
Hold NOAC for 24 h	48/89 (54%)	53/89 (60%)
Hold NOAC for 48 h	7/89 (8%)	11/89 (12%)
Other strategy	3/89 (3%)	6/89 (7%)
Post-procedural NOAC use		
Immediately following procedure	7/89 (8%)	7/89 (8%)
4 h post-procedure	5/89 (6%)	9/89 (10%)
4–6 h post-procedure	24/89 (26%)	28/89 (31%)
6–24 h post-procedure	22/89 (25%)	26/89 (29%)
Continue NOAC throughout ablation procedure	31/89 (35%)	19/89 (22%)
Long-term OAC therapy post ablation		
Discontinue immediately after ablation procedure	2/89(2%)	1/89 (1%)
is used routinely 4 weeks after procedure	4/89 (5%)	4/89 (5%)
OAC is used routinely 3 months after procedure	8/89 (9%)	7/89 (8%)
OAC is used routinely >3 months after procedure	5 89 (6%)	14/89 (16%)
>4 weeks, history of AF	18/89 (20%)	11/89 (12%)
>4 weeks, high-risk patient (CHA_2DS_2-VAS_C ≥2)	51/89 (57%)	51/89 (57%)
Unknown	1/89 (1%)	1/89 (1%)

CTI, cavotricuspid isthmus; LMWH, low-molecular-weight heparin; NOAC, non-vitamin K antagonist oral anticoagulant; VKA, vitamin K antagonist.

thrombus. There were no significant differences in responses between European and Canadian operators.

Procedural details

In a patient with a history of both CTI-dependent AFL and AF 45/85 respondents (53%) would first perform AFL ablation alone if the AFL was considered to be the predominant arrhythmia, 13/85 (15%) would perform AFL ablation alone even if the AFL was not deemed to be the predominant arrhythmia, and 27/85 respondents (32%) would perform a combined CTI ablation and AF ablation. There were no significant differences in response between European and Canadian operators (*Figure 1*).

For patients with CTI-dependent AFL 26/84 respondents (31%) used a coronary sinus and ablation catheter only, 6/84 (7%) used a coronary sinus, right ventricular and ablation catheter and 47/84 respondents (56%) also used a multielectrode catheter in the right atrium (RA). Some respondents (*n* = 2/84, 2%) also included the use of an electroanatomic mapping (EAM) system and mapping catheters related to the EAM system. For CTI-dependent AFL only 2/67 respondents (3%) routinely used EAM for all cases while 66/67 respondents (99%) used an EAM for non-CTI dependent AFL. There were no significant differences in diagnostic catheter setup between Europe and Canada (*Figure 2*).

Mapping of the tachycardia using a multielectrode catheter or repositioning a bipolar catheter to assess the activation sequence was used by 61/68 respondents (90%) for CTI-dependent AFL and by 47/68 respondents (69%) for non-CTI dependent AFL. Entrainment was used by 70/78 respondents (90%) to confirm the diagnosis of CTI-dependent AFL and by 73/78 respondents (94%) for non-CTI dependent AFL.

For patients with CTI-dependent AFL 54/83 respondents (65%) used a 4 mm irrigated non-contact force catheter, 11/83 (13%) used a 4 mm irrigated contact force catheter, 1/83 (1%) used a non-irrigated 4 mm catheter, and 17/83 respondents (21%) used an 8 mm catheter for the majority of their cases. For non-CTI dependent AFL 28/83 respondents (34%) used a 4 mm irrigated non-contact force catheter, 47/83 (57%) used a 4 mm irrigated contact force catheter, 3/83 (4%) used a 4 mm non-irrigated catheter and 5/83 respondents (6%) used an 8 mm catheter for the majority of their cases. As shown in *Figure 2*, there was a significantly greater preference for the use of 8 mm ablation catheters in Europe compared with Canada for the

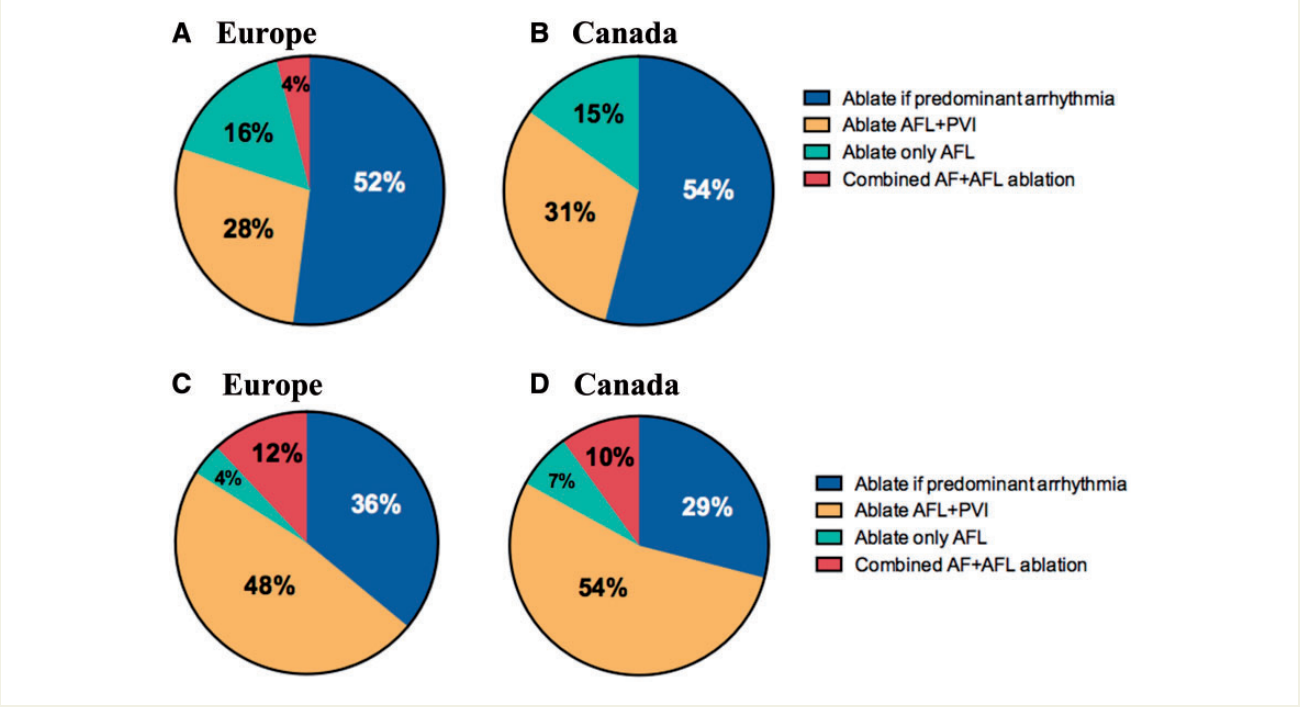

Figure 1 Region-specific comparison of treatment strategy in patients with history of AF for CTI-dependent AFL ablation in Europe (*A*) and Canada (*B*) and non CTI-dependent AFL in Europe (*C*), and Canada (*D*). AF, atrial fibrillation; AFL, atrial flutter; CTI, cavotricuspid isthmus; PVI, pulmonary vein isolation.

catheter ablation of CTI-dependent AFL (9/25 respondents, [36%] in Europe vs. 8/58 respondents [14%] in Canada; $P = 0.021$). For non-CTI dependent AFL ablation there was a significantly greater preference for the use of 4 mm contact force catheters in Canada compared with Europe (9/25 respondents [36%] in Europe vs. 37/58 respondents [63%] in Canada; $P = 0.019$).

Bidirectional CTI block was used as the desired endpoint in ablation procedures for CTI-dependent-AFL by 83/85 respondents (95%). The most common method of assessing for bidirectional block was by using multisite pacing with the ablation catheter by 74/76 respondents (97%); 47/76 (62%) of these respondents also used a multielectrode catheter and 45/76 respondents (59%) used double potentials along the ablation line.

For patients with non-CTI dependent AFL, termination of the tachycardia with ablation alone was considered indicative of a successful ablation by 8/85 respondents (9%) while 17/85 respondents (20%) required non-inducibility of the clinical arrhythmia as an endpoint and 18/85 (21%) considered non-inducibility of any arrhythmia as an endpoint. The remaining 42/85 respondents (49%) considered block across an ablation line as a suitable endpoint. There were no differences in terms of endpoints for catheter ablation for CTI-dependent AFL and non-CTI dependent AFL between Europe and Canada.

Postprocedural management

In patients in whom NOAC therapy was stopped before ablation 7/89 (8%) of respondents would restart NOACs immediately after the procedure, 5/89 (6%) would restart NOACs 4 h after the procedure, 24/89 (26%) would restart NOAC therapy 4 to 6 h after the procedure, and 22/89 respondents (25%) would restart NOAC therapy from 6 to 24 h after the procedure. For non-CTI dependent AFL 7/89 respondents (8%) would restart NOAC therapy immediately after the procedure, 9/89 (10%) would re-initiate NOAC therapy 4 h after the procedure, 28/89 (32%) would restart NOAC therapy 4 to 6 h after the procedure, and 26/89 respondents (29%) would restart the NOAC therapy 6 to 24 h after the procedure. This practice did not vary significantly between responses from Europe and Canada.

For patients who had undergone an apparently successful CTI ablation, oral anticoagulation was routinely stopped at the time of the procedure by 2/89 respondents (2%), 4 weeks after the procedure by 4/89 (5%), 3 months after the procedure by 8/89 (9%), and more than 3 months after the procedure by 5/89 respondents (6%) irrespective of the patient's CHA_2DS_2-VAS_C score. However, 18/89 respondents (20%) would recommend continuing oral anticoagulation indefinitely in patients with a history of AF and 51/89 respondents (57%) would recommend continuing oral anticoagulation indefinitely in such patients only if their CHA_2DS_2-VAS_C score is ≥ 2. For patients who underwent an apparently successful ablation for non-CTI dependent, 1/89 respondents (1%) routinely stop oral anticoagulation at the time of the procedure, 4/89 (5%) stop oral anticoagulation 4 weeks after the procedure, 7/89 (8%) stop oral anticoagulation 3 months after the procedure, 14/89 (16%) stop oral anticoagulation more than 3 months after the procedure irrespective of the CHA_2DS_2-VAS_C score. In patients with a history of AF, indefinite continuation of oral anticoagulant therapy is recommended irrespectively of the CHA_2DS_2-VAS_C score value by 11/89 respondents

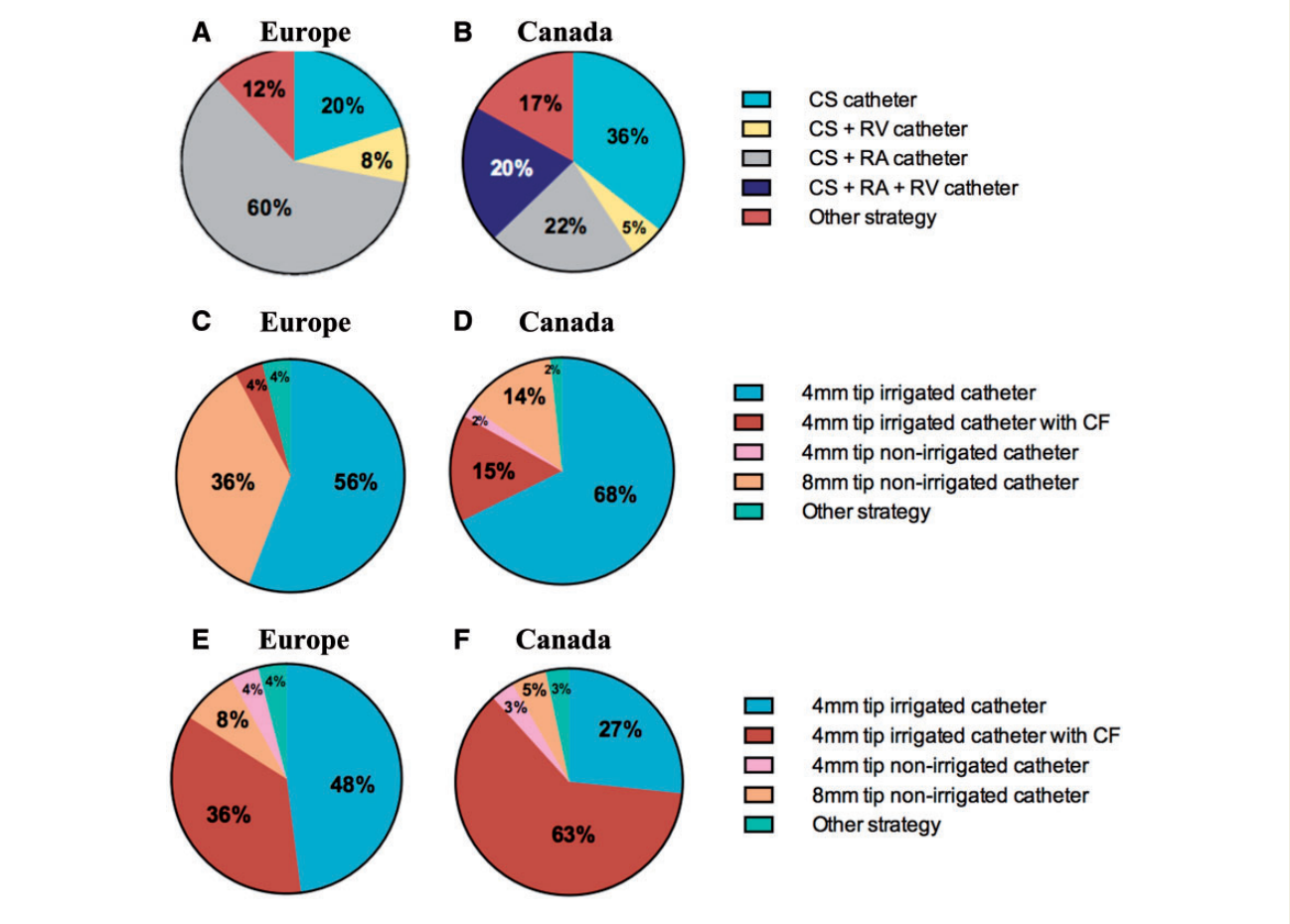

Figure 2 Region-specific comparison of diagnostic catheter setup for CTI-dependent AFL ablation in Europe (*A*) and Canada (*B*) as well as ablation catheter choice for CTI-dependent AFL in Europe (*C*) and Canada (*D*) and non CTI-dependent AFL in Europe (*E*), and Canada (*F*). CF, contact force; CS, coronary sinus; CTI, cavotricuspid isthmus; RA, right atrium; RV, right ventricle.

(12%), or only if the CHA_2DS_2-VAS_C score equals ≥2 (51/89 respondents, 57%). There were no differences between Europe and Canada in terms of the management of longer term oral anticoagulation in patients who had undergone catheter ablation for either CTI-dependent or non-CTI-dependent AFL.

Discussion

Given the high success and relatively low complication rates for CTI-dependent AFL catheter ablation should be considered in both symptomatic and recurrent AFL.[5,6] Almost all respondents in this survey considered CTI ablation an appropriate therapy as either first line therapy or following at least one electrical cardioversion for AFL. The majority (almost 75%) of respondents also considered catheter ablation to be first line therapy for the treatment of non-CTI-dependent AFL. This likely reflects the fact that the majority of these tend to occur after a catheter ablation for AF with a high recurrence rate despite the use of anti-arrhythmic drug therapy.

Patients with AFL are presumed to have a similar risk of thromboembolism to those with AF.[3,7] The guidelines for oral anticoagulation in patients with AFL, therefore, recommend that oral anticoagulation for these patients should be identical to those undergoing catheter ablation for AF i.e. a minimum of 4 weeks prior to (in all but the lowest risk patients) and 8 weeks following the ablation with the longer term decision should be based on the patients CHA_2DS_2-VAS_C score.[8] Almost 80% of respondents recommended that they would commence oral anticoagulation at least 3 weeks prior to a catheter ablation for either CTI-dependent or non-CTI-dependent AFL. The majority of respondents (77%) in our survey also started that they would continue with longer term oral anticoagulation in patient with either a history of AF or a higher CHA_2DS_2-VAS_C score which is in keeping with recommendations.

There is an overall lack of consensus on the periprocedural use of NOAC agents in the catheter ablation of AFL or AF. Although there is data for the use of safety of uninterrupted NOAC's in AF ablations compared with uninterrupted VKA,[9] these studies are small and the lack of an overall recommendation is likely reflected by the variability in responses in this survey between individual operators and between continents with a higher number of respondents continuing NOAC usage during CTI ablation in Europe. The majority of respondents did not stop oral anticoagulation for greater than 24 h prior to the

procedure. If the last does of NOAC is taken more than 36 h prior to catheter ablation a TEE is recommended[10] and this may explain why the majority of operators opted not to perform a TEE prior to catheter ablation for CTI-dependent and to a lesser extent non-CTI-dependent AFL.

In patients with a history of both AFL and AF, catheter ablation techniques targeting the right atrial isthmus for CTI-dependent AFL or pulmonary vein isolation for AF have been shown to achieve effective outcomes in the treatment of these arrhythmias.[11] Nevertheless, the timing of consideration of the two procedures in patients with both arrhythmias is debated. In this survey, approximately two-thirds of operators stated that they would ablate AFL first and reassess the patient later irrespective of whether AFL was the predominant rhythm or not. The remaining one-third of operators stated that they would perform an ablation procedure for both typical flutter and AF during the same procedure. Given the high recurrence rate of AF in follow-up after an AFL ablation there may be merit in performing a combined procedure. This must be weighed against the potential for additional complications of a catheter ablation for AF in patients whose dominant clinical rhythm is AFL. Clearly, further studies are required in order to assess more precise risk factors for development of AF after an AFL ablation.

Approximately, 80% of the responding operators use an irrigated 4 mm catheter for the ablation of CTI-dependent AFL with the majority of the remaining operators using a 8 mm catheter. Just over 10% of operators are currently using contact force catheters for a CTI ablation. The use of contact force irrigated 4 mm catheter was considered by almost 60% of operators for use in the ablation of non-CTI dependent AFL. There is no evidence to suggest that 8 mm catheters are more efficacious than 4 mm irrigated catheters for the treatment of AFL.[10] Although there is evidence of an advantage to the use of contact force catheters in performing AF catheter ablations by virtue of a lower probability of acute pulmonary vein reconnection,[11] similar data is lacking for both CTI-dependent and non-CTI dependent AFL ablations.

Conclusions

The results of this survey show some variability in clinical practice among operators with respect to the periprocedural and procedural details of catheter ablation for patients with AFL. There is reasonable consensus regarding oral anticoagulation and the desired endpoints of ablation for patients with CTI-dependent AFL and for non-CTI-AFL. The variability in opinion regarding other procedural details speaks to the need for further research and a consideration to develop guidelines in this area.

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