Consensus document on antithrombotic therapy in the setting of electrophysiological procedures

Jean Jacques Blanc, (Chair; Brest, FR)*, Jesus Almendral, (Co-chair; Madrid, SP), Michele Brignole, (Lavagna, IT), Marjaneh Fatemi, (Brest, FR), Knut Gjesdal, (Oslo, N), Esteban González-Torrecilla, (Madrid, SP), Piotr Kulakowski, (Warsaw, PL), Gregory Y.H. Lip, (Birmingham, UK), Dipen Shah, (Geneva, CH), and Christian Wolpert, (Mannheim, DE), on behalf of the Scientific Initiatives Committee of the European Heart Rhythm Association

Received 28 March 2008; accepted after revision 28 March 2008

Preamble

Guidelines and Expert Consensus documents are proposed to help physicians to select the best possible diagnostic or therapeutic strategies for an individual patient with a specific disease. Recommendations issued from these documents are based on an extensive review of the literature and on discussions among experts when hard data are incomplete or missing. It has been shown that patient outcomes improve when guidelines recommendations are applied in clinical practice. Publication and promotion of these guidelines is one of the most important tasks of scientific societies. The recently created European Heart Rhythm Association (EHRA) wants to meet this commitment in its specific field of competence and one assignment of the scientific committee of EHRA is to propose and promote Guidelines in the management of heart rhythm disturbances not already covered by the European Society of Cardiology (ESC).

Introduction

Electrophysiological studies (EPSs), whether or not associated with therapeutic procedures (ablation using different sources of energy or reduction of tachycardia), show the percutaneous introduction of one or multiple catheters to record the electrical activity of the heart or to pace its different cavities. The introduction and manipulation of these catheters in arteries, veins, or cardiac cavities have multiple pathophysiological consequences and one of the most evident is to activate the coagulation cascade with the risk to induce new clots or to mobilize pre-existing ones. Furthermore, withdrawal of catheters induces haemorrhage usually limited by the compression of the site of venous or arterial puncture.

There is also a close relationship between EPS and thrombus formation (thrombogenesis) and thus, rhythmologists need to balance the risks between thrombo-embolism and bleeding. There are no guidelines on the use of antithrombotic therapies in the setting (before, during, and after) of EPS. Generally, different laboratories have their own approaches to this clinical problem.

The aim of the present document is to propose consensus recommendations written according to the ‘Guidelines for guidelines’ published by the Guidelines committee of the ESC. It should be stressed that this topic has been poorly studied in clinical trials and that very few well-designed studies are at our disposal to guide evidence-based management. This is a major limitation to give hard recommendations and explains why the level of recommendation in most instances is Grade C (‘expert opinion’).

The present document has been divided into five main sections: the first three deals with the general risks of thrombo-embolism or bleeding, whereas the fourth section relates more to the risks of venous or arterial access and the last section relates to some special situations. The division between low-, intermediate-, and high-risk procedures for thrombo-embolism or bleeding is partly arbitrary, as a ‘low-risk’ intervention in a high-risk patient becomes an intermediate-risk procedure. Even with these limitations, such a division could be helpful for readers.

It is the hope of the task force that this document will prompt well-designed trials that would hopefully strengthen the impact of the following recommendations.

Epidemiology

Radiofrequency (RF) catheter ablation, because of its curative nature and high success and low complication rates, has become the treatment of choice for a wide variety of
arrhythmias. Indications have recently expanded to include even complex arrhythmias such as atrial fibrillation (AF), atrial flutter (AFL), and ventricular tachycardia (VT) associated with structural heart disease.

A recent review indicates an overall low incidence of 0.6% of reported thrombo-embolic complications; the risk was increased when an ablation procedure was performed in the left heart (1.6–2.8%).\(^1\)\(^-\)\(^3\) In an earlier survey,\(^4\) the reported procedure-related complications of RF ablation occur in ~5.1%. The risk is also high when the ablation procedure is performed in the left heart (1.8–2%) and for VT (2.8%).\(^3\)

### Atrial fibrillation

Non-pharmacological measures play an increasing role in AF management and, in many instances, offer the possibility of a 'cure'.\(^4\) However, AF recurrence rates with catheter ablation techniques are significant. For example, only 54 and 82% of the patients remained free of arrhythmia-related symptoms at the 6-month follow-up period, after circumferential pulmonary vein ablation and segmental pulmonary vein ablation for AF, respectively.\(^5\) Also, asymptomatic AF episodes can occur and may be increased after catheter ablation, especially among previously symptomatic patients.\(^6\)

In a 'real world' survey of the methods, efficacy, and safety of catheter ablation for AF, there was a clear relation of procedural success and complications to centre expertise and follow-up duration.\(^7\) Major complications did occur in 5.9%, and for procedures involving left atrial (LA) ablation, the prevalence of stroke was 0.28% and that of transient ischaemic attack was 0.66%. This needs to be put in context of other complications, including mortality (0.05%) and tamponade (1.22%).

Clearly, practice from individual centre series varies from registry data.\(^8\)\(^-\)\(^11\) During a follow-up of 33.6 months, Gasparini et al.\(^9\) reported that thrombo-embolic events were observed in 17 patients (3%); the actuarial occurrence rates of thrombo-embolism were 1.1, 3, 4.2, and 7.4% after 1, 3, 5, and 7 years, respectively. In the multivariate analysis, the only predictor of embolic events during follow-up was the presence of chronic AF. There was a relatively low incidence (1.04% per year) of thrombo-embolic events after AV node ablation and pacing for drug refractory, high rate AF. Oral et al.\(^10\) recently reported a study of percutaneous LA RF ablation in 755 consecutive patients with paroxysmal (\(n = 490\)) or chronic (\(n = 265\)) AF, of which 411 (56%) had one or more risk factors for stroke. All patients were anticoagulated with warfarin for \(\geq 3\) months after LA RF ablation. Thrombo-embolism occurred in seven patients (0.9%) within 2 weeks of LA RF ablation, whereas late thrombo-embolism occurred 6–10 months after ablation in two patients (0.2%), one of whom still had AF, despite therapeutic anticoagulation in both. None of the patients in whom anticoagulation was discontinued had a thrombo-embolic event during 25 months of follow-up. They concluded that the risk of thrombo-embolism after LA RF ablation is 1.1%, with most events occurring within 2 weeks after the procedure. Indeed, thrombo-embolism may still occur, despite the appearance of sinus rhythm maintenance.\(^11\)

### Atrial flutter

Radiofrequency catheter ablation of isthmus-dependent AFL is considered the therapeutic strategy of choice. Gronefeld et al.\(^12\) reported a case series of 201 patients with AFL: 62 were not on therapeutic anticoagulation, and had a relative risk for thrombo-embolism of 12.5 [95% confidence interval (CI): 3–55, \(P < 0.001\)].

### Pathophysiology

#### Mechanisms of thrombo-embolism in electrophysiological procedures

The mechanisms of thrombo-embolism peri-ablation have been open to much speculation.\(^13\) About 150 years ago, Virchow proposed a triad of abnormalities that predispose to thrombus formation—flow abnormalities, abnormalities of the vessel wall, and abnormal blood constituents. The pathophysiology of thrombo-embolism is therefore multifactorial, but increasing evidence points to the fulfilment of Virchow’s triad in the context of an electrophysiological procedure leading to a prothrombotic or hypercoagulable state.\(^13\)

In the setting of complex catheter ablation procedures, thrombo-embolic complications result most commonly from the embolization of thrombi of cardiogenic origin. As an illustrative example, in AF ablation, possibilities include a reduction in the LA function, endocardial/tissue damage leading to a prothrombotic surface on the endocardium, activation \(per se\) of coagulation and platelets, and so on. However, this may be an over-simplification, as athero-embolic plaques from major arteries, calcific debris from systemic valves, and paradoxical emboli generated in the right side of the circulation have all been shown to give rise to embolic complications. Bubbles of air are frequently sucked into long sheaths during catheter withdrawal and can be embolized into the systemic circulation by flushing or catheter re-introduction. Thrombi formed in situ within the long sheaths may embolize with an improper flushing technique. Rarely, catheter debris or broken off bits may also be embolized. Theoretically, insufficiently anchored thrombus can be launched into the circulating bloodstream by a vigorous contraction—e.g. by a post-cardioversion beat (and supplemented in variable measure by the shock of electrical cardioversion) or by catheter manipulation or as pointed out—flushing, or catheter re-introduction within long sheaths. In the clinical setting where multiple factors usually coexist, a multi-pronged approach is therefore appropriate to minimize or prevent these complications.

#### Abnormal blood flow

During medium-term follow-up, restoration of sinus rhythm by LA ablation results in partial return of LA function in patients with chronic AF, whereas in patients with paroxysmal AF, LA catheter ablation results in decreased LA function.\(^14\) Also, ablation of AFL has been associated with significant LA stunning and the development of spontaneous echo contrast,\(^15\) perhaps indicating more stasis within the left atrium.

Atrial stunning is defined by transient atrial mechanical dysfunction that follows conversion of AF to normal sinus rhythm. It has been reported with all modes of conversion
of AF, including RF ablation. Atrial stunning results in para-
doxical reduction of LA and LA appendage blood flow vel-
cocities. There is strong evidence to suggest that this
condition is responsible for an increased risk of
thrombo-embolism for hours to weeks after conversion of
AF in to sinus rhythm and results in a five-fold increase in
the risk of stroke. The time delay for atrial function to
recover is dependent on the duration of the arrhythmia,
the atrial size, and underlying heart disease.

Left atrial mechanical dysfunction induced by ablation
may contribute to ‘abnormal flow’ and thrombogenesis.
As extensive lesions in the left atrium are required to
achieve complete pulmonary vein disconnection, one
might speculate that AF ablation results in significant
atrial dysfunction. In contrast, maintenance of sinus
rhythm following ablation should result in reverse atrial
remodelling and recovery of atrial function. In a study by
Beukema et al.,17 patients who remain free of AF recur-
rence after ablation demonstrate significant decrease in
LA cavity size, whereas in those with recurrent AF, LA
dimension increased compared with baseline. In another
study in which LA function was determined by measuring
LA ejection fraction, in patients with paroxysmal AF, abla-
tion resulted in more depressed LA function when compared
with baseline. In patients with chronic AF, there was partial
recovery of LA function. In both the cases, LA ejection frac-
tion was lower than that in control subjects.18 Whether the
impairment of the left atrium is severe enough to predis-
pose to thrombus formation despite elimination of AF
remains to be determined.

Abnormal vessel wall
The heating of tissue and/or blood during RF current
delivery, or defibrillation energy with an atroieverter, may
leave a damaged endocardial/endothelial surface that
activates the coagulation system.19 Tissue overheating
during current delivery may even result in gas formation,
with audible ‘popping’. The type of sheath used, given the
nature of the foreign substance within the blood, as well
as the procedure duration, would have implications for
thrombogenesis.

In one study in which thrombus formation was documen-
ted by intracardiac echocardiography19 during pulmonary
vein isolation, 50% of the thrombi developed before RF
application and after transseptal catheterization, and in
the remaining patients, it developed after RF delivery. In
both groups, thrombi were attached either to the sheath
or to the lasso catheter and never to the ablation catheter.
Interestingly, no mural or mobile thrombus attached to RF
lesion was observed.

In one of the rare studies20 to look at clinical thrombo-
embolic events (TEE) during LA ablations (including both
AF and left AFL), the authors observed a high incidence
with a strategy of low flow (3 cc/h) heparinized perfusion
of the long LA sheath. When they changed to a high flow
(180 cc/h) perfusion of the long sheath placed into the left
atrium, they observed no more TEE in 54 subsequent
similar cases. Although limited by its retrospective nature,
this observational study highlights an important mechanism
of thrombus generation and embolization: stasis within the
long sheath (low flow perfusion) leads to the formation of
a thrombus, which is then pushed into the left atrium by
resumption of an interrupted flushing perfusion or another
catheter. The filamentous shape of many intracardiac
thrombi and their attachment to the sheath tip clearly cor-
roraborate this mechanism. Therefore, a proper technique
should be applied. Withdrawal of 2–3 cc of blood content
from short sheaths and more from long ones with use of a
separate syringe should precede regular flushing with the
use of clean heparized saline, thus ensuring avoidance of
introducing thrombi already formed within the sheath; this
should be repeated periodically unless a high flow perfusion
technique is employed and also every time a new catheter is
inserted into the sheath. Finally, a catheter should be intro-
duced if blood cannot be freely withdrawn and proper flush-
ning can not be completed.

The type of ablation procedure may itself influence
thrombogenesis and may reflect the extent of tissue
injury. Pulmonary vein disconnection with or without
additional lesion lines is required to cure AF. Radiofre-
quency energy application results in a spherical-shaped
area of necrosis surrounded by a haemorrhagic zone
because of resistive heating of the tissue. Pathological
studies in animals have shown thrombus formation on the
lesion.21 In contrast, if tissue temperature exceeds 100 C
during RF application, thrombus develops at the tip of the
ablation catheter. Thrombus formation decreases the
efficacy of RF application and is also a potential source of
embolization.22

Air can also be sucked in through the non-return valve
(which is designed primarily to prevent blood from leaking
out) when a catheter is rapidly pulled out of the long LA
sheath and then embolizes out into the left atrium. Fortu-
nately, the commonest clinical manifestation is transient
ST-elevation, typically in a right coronary distribution
with accompanying angina. Aspirating the sheath side arm
with a finger or thumb over the sheath valve (to prevent
further air aspiration) or simply letting the side-arm bleed
passively (with a few taps on the valve to dislodge trapped
bubbles) after each catheter withdrawal and before
resuming sheath perfusion may significantly reduce this
complication.

Abnormal blood constituents
Abnormalities of procoagulant blood constituents are well
recognized in relation to ablation procedures.

Thrombus formation can represent predominantly fibrin-
rich clot (‘red clot’) or predominantly platelet-rich throm-
bus (‘white clot’). In AF, thrombus is mainly fibrin-rich and
is reflected by immunohistological data23 and by the dra-
matic reduction of stroke with anticoagulation therapy
when compared with antplatelet therapy.24 Reduction of
stroke with aspirin in AF is similar to the 22% odds reduction
of vascular events by antplatelet therapy in ‘high-risk’ vas-
cular disease patients, in whom aspirin 75–325 mg daily is
commonly prescribed.25

In atherosclerotic vascular disease, thrombus formation
is mainly platelet-rich, and thus, antplatelet therapy is ben-
ficial. This is evident in the setting of coronary artery
disease.26 Evidence supporting increased platelet activation
in AF has been provided by numerous studies,27 but the
platelet activation in AF is not beyond that which would
be expected from associated vascular disease.

Following ablation, there is some evidence of significant
haemostatic activation.28 For example, Manolis et al.29
reported increased fibrin D-dimer levels, an index of
intravascular thrombogenesis post-ablation, irrespective of heparin therapy usage. In another study, Michelucci et al. found that coagulation system and platelets were activated immediately after electrophysiological and ablation procedures, but this returned to normal by 24 h post-procedure. In a study conducted on 37 patients, fibrin D-dimer and thrombin-antithrombin levels (as indices of thrombogenesis) were measured at baseline, after sheath insertion, after electrophysiological study but before ablation, at the completion of the procedure, and at 24 h post-procedure. D-dimer levels increased significantly from baseline values after sheath insertion. There was a further significant increase after electrophysiological study was performed and a slight but not significant increase was observed after ablation. D-dimer levels remained elevated at 24 h. Procedure duration was the only predictor of increased thrombogenicity.

Different modalities of ablation may result in the differential activation of platelets and coagulation activity. For example, an RF procedure induces significantly more platelet activation and haemostasis than the conventional cryo-application procedure. Given that thrombin is one of the most potent stimulants of platelets, anticoagulation therapy will still remain the cornerstone of antithrombotic management per-ablation, but the role of antiplatelet therapy as monotherapy, combination therapy (e.g. aspirin–clopidogrel or aspirin–ticlopidine) or co-administered with warfarin remains uncertain given the lack of large clinical trials addressing this issue.

In summary, electrophysiological interventions may confer a prothrombotic state by the fulfilment of various components of Virchow's triad for thrombogenesis.

Associated comorbid conditions

Although several factors have been identified to increase the thrombo-embolic risk of AF, not all of them have been studied during AF ablation. Given the interest into stroke and thrombo-embolism following a rhythm control strategy compared with a rate control strategy, it is clear that anticoagulation is an independent predictor of survival. Thus, current recommendations for anticoagulation emphasize the need for continuation of anticoagulation therapy beyond 4 weeks post-cardioversion where there is a high risk of AF recurrence and/or stroke risk factors are present.

Thrombus formation during AF ablation as determined by intracardiac echocardiography could be related to increased LA size, spontaneous echo contrast, and persistent AF. The most important determinant of thrombus formation was the presence of spontaneous echo contrast, as nearly as 70% of the patients with this condition develop LA thrombus. In contrast, LA size and ischaemic heart disease are associated with increased incidence of atrial stunning, which also favours thrombus formation.

Measures to minimize thrombo-embolic complications

The adjunctive administration of specific inhibitors of platelet activation, application of intraprocedural intracardiac echocardiography, irrigated RF ablation, and cryoablation catheter systems could all potentially reduce the risk of thrombo-embolism during ablation. Randomized trials are lacking and much of the evidence is based on clinical practice reports or case series. In a single-centre study, for example, intravenous heparin was administered with an initial bolus of 5000 U followed by 1000 U/h for the duration of the procedure in 376 patients undergoing right- and left-sided ablation. Neither warfarin nor aspirin was given after ablation. No embolic complication occurred, and deep vein thrombosis was observed in three patients (0.8%).

Prolonged anticoagulant therapy in 'high-risk' patients

Most physicians recommend continued anticoagulant therapy following RF ablation. However, the optimal duration of this therapy has not been clearly established. When RF is performed during AF, atrial stunning following conversion to sinus rhythm (SR) favours thrombo-embolic complications and, therefore, anticoagulation should at least be maintained until recovery of atrial function—the latter is a function of LA size, duration of AF and the underlying heart disease. However, owing to the risk of relapse, current guidelines recommend that anticoagulation should be continued long-term in subjects with stroke risk factors and those at high risk of AF recurrence.

Some assurance that there is no arrhythmia recurrence before discontinuation of anticoagulation can be considered. In a series of 755 patients undergoing AF ablation, 1% had thrombo-embolic complications. In 0.9% of the patients, thrombo-embolism occurred within 2 weeks of the procedure, and in 0.2% (two patients), late thrombo-embolism was observed at 6–10 months, despite therapeutic anticoagulation level. Among patients who remained in SR and had no risk factor, anticoagulation was discontinued in 79% at a median of 4 months. Among those who remained in sinus rhythm and had one or more risk factors, anticoagulation was discontinued in 68% of the patients at a median of 5 months. In patients who had AF recurrence (233 patients), anticoagulation was discontinued in 6% of the patients. None of the patients who were taken off anticoagulants had late thrombo-embolism during the 25 months of follow-up. Patients older than 65 years or with a history of stroke were more likely to remain anticoagulated despite successful outcome of AF ablation. On the basis of the results of this study, it is probably safe to discontinue anticoagulant therapy after 4–5 months in patients with successful ablation of AF and no risk factor or with risk factors other than age >65 years and history of stroke.

There are insufficient data to support discontinuation of anticoagulation in patients older than 65 years or with a history of stroke. In another large-scale non-randomized study in which pulmonary vein isolation was compared with anti-arrhythmic drug therapy, no early thrombo-embolism was observed following ablation. Late thrombo-embolism was observed in 2.5% of the patients in the ablation group and 10% of the patients in the medically treated group; 54 and 49% of ablated and medically managed patients, respectively, had thrombo-embolism while receiving inadequate anticoagulation. Thrombo-embolic complications were significantly more frequent among patients who had AF recurrence suggesting the continuation of anticoagulation in patients with unsuccessful outcome of ablation.
Intravenous heparin

Intravenous heparin is extensively used to prevent thrombo-embolic complications of RF ablations performed in left-side cavities. Although thrombus formation is not completely eliminated by heparin infusion, increased intensity of anticoagulation may reduce the risk of embolic events during AF ablation. Wazni et al.\textsuperscript{37} performed a study on 785 patients who underwent AF ablation. Patients who had activated coagulation time (ACT) maintained between 350 and 400 ms were less likely to develop char or have TEE than those in whom the ACT was between 250 and 300 ms. Similarly, Ren et al.\textsuperscript{38} reported reduced risk of LA thrombus in patients with spontaneous echo contrast by maintaining the ACT $>300$ ms. The use of platelet inhibition with eptifibatide did not have incremental beneficial effect.

Aspirin and ticlopidine or clopidogrel

Limited data are available on the role of dual antiplatelet therapy as thromboprophylaxis in electrophysiological interventions. As discussed later (see ‘Special situations’ section) many patients undergoing ablation may have had associated coronary disease and/or stents, which require the use of such drugs, and bleeding complications may be an issue.\textsuperscript{26}

Combination therapy may have some potential to reduce the propensity to thrombogenesis when compared with monotherapy. In a study conducted on 59 patients undergoing RF ablation,\textsuperscript{39} pre-treatment with aspirin or ticlopidine alone did not decrease the thrombogenic potential of RF ablation, although combined therapy with aspirin and ticlopidine had a favourable effect, as reflected by the lower degree of D-dimer elevation when compared with baseline. Nonetheless, these are data based on surrogate endpoints and should be considered in context of other data in relation to the lack of benefit of aspirin–clopidogrel in reducing thrombogenesis in AF\textsuperscript{40} and clinical trials that show superiority of warfarin over aspirin–clopidogrel combination therapy.\textsuperscript{41}

Temperature control during radiofrequency ablation

For irreversible injury to occur during RF application, a tissue temperature of at least 50°C must be achieved. As temperature increases, lesion size also increases. However, if temperature exceeds 100°C, coagulation (or thrombus?) develops.\textsuperscript{22} Temperature monitoring with closed-loop control of power during RF application minimizes the likelihood of developing coagulum while ensuring maximum lesion formation. It has been demonstrated that below an electrode temperature of 70°C, thrombus was observed in 0% of RF applications vs. 7% of applications when the target temperature was $\geq 85$°C.\textsuperscript{42}

Irrigated-tip catheter

Irrigation of the ablation electrode has been demonstrated to reduce the risk of thrombus formation at the tip of the electrode.\textsuperscript{43} A direct comparison \textit{in vitro} between an externally irrigated (shower tip) catheter and a closed circuit internally irrigated ablation catheter clearly showed that coagulum generation correlated very well with elevated electrode–tissue interface temperature and that little or no coagulum was observed with an externally irrigated catheter.\textsuperscript{44} In a single-centre study conducted on 52 consecutive patients with AF, the use of irrigated-tip catheter was demonstrated to be safe with low complication rates and a reasonable medium-term success rate: 81% of the patients were in sinus rhythm, 33% of whom required additional antiarrhythmic therapy. At the end of the ablation procedure, no signs of coagulum formation were present around the tip of the catheter.\textsuperscript{45}

Alternative energy sources for tissue ablation

In an animal study,\textsuperscript{46} the use of cryoenergy resulted in less thrombus formation than RF (30.1 vs. 75.8%). Cryoablation was also associated with smaller thrombi (0.8 vs. 5.4 mm$^3$). However, human studies are lacking to confirm safety and efficacy of this method in the ablation of human AF. Other alternative energy sources such as microwave, laser, or ultrasound energy all result in tissue heating; although clinical data are lacking, there is no reason to anticipate any reduction in thrombo-embolic potential.

Other measures

Limited data exist on other therapeutic strategies for dealing with catheter-related thrombus during electrophysiological interventions. Thrombus dissolution should be possible with fibrinolytic therapy, and such agents are used in the management of acute myocardial infarction and acute shunt thrombosis. Concern remains on the feasibility of local delivery of such agents, as well as embolism of thrombus fragments during (partial) dissolution.

The role of echocardiography

Intracardiac echocardiography

Intracardiac echocardiography monitoring during RF applications allows early detection of LA thrombi that can be removed by withdrawal of the sheath and catheter into the right atrium. However, the clinical significance of these thrombi is not clear.\textsuperscript{19} Ren et al.\textsuperscript{38} reported a 10% incidence of thrombus formation as identified by intracardiac echocardiography imaging. In most series of AF ablation the incidence of clinical thrombo-embolism is much less than this value. In contrast, patients with spontaneous echo contrast are more likely to develop thrombus during RF procedure. Identification of these patients by intracardiac echocardiography imaging is, therefore, important. In another study,\textsuperscript{38} increased intensity of anticoagulation may reduce risk of thrombus during AF ablation in patients with spontaneous echo contrast that is when ACT was $>300$ ms, LA thrombus was observed in only 4.6% of the patients, whereas when ACT was between 250 and 300 ms, the risk of thrombus was 44.9%. Intracardiac echocardiography imaging has also been used to monitor micro-bubble formation during RF delivery, considered to reflect tissue heating. Marrouche et al.\textsuperscript{47} showed that RF power reduction prompted by an increase in the micro-bubble formation was associated with the lowest incidence of complications, including thrombo-embolism and pulmonary vein stenoses.

Transoesophageal echocardiography

Transoesophageal echocardiography (TOE) is useful to identify spontaneous echo contrast, which is associated with an
increased incidence of thrombus formation during RF, and to detect LA thrombus which contraindicates ablation. After conversion to sinus rhythm following ablation, TOE might be helpful to assess the severity of LA stunning by measuring LA appendage velocities and emptying fraction.

**Risk stratification**

**Low-risk procedures: right-side interventions (atrial tachycardias, kent bundle, and junctional and ventricular tachycardia) except those performed during atrial flutter**

**Thrombo-embolic vs. bleeding complications**

In the MERFS retrospective registry, among 2171 patients who performed right-sided ablation (AV node re-entrant tachycardia or AV junction ablation), there were 1 case of cerebral embolism (0.06%), 4 cases of pulmonary embolism (0.23%), and 18 cases of venous thrombosis (1.04%). Conversely, there were three cases of pericardial tamponade (0.17%), seven cases of pericardial effusion (0.41%), and two cases of major bleeding/haematoma (0.11%).

In the 1998 NASPE prospective catheter ablation registry, among 2142 patients with right-sided ablation (AV node re-entrant tachycardia, AV junction ablation, right-sided accessory pathway or atrial tachycardia) there were three cases (0.14%) of thrombo-embolism (pulmonary or venous), two cases (0.09%) of pericardial tamponade, and six cases (0.28%) of major bleeding/haematoma. In the Atakr prospective multicentre registry performed in 11 centres, embolic complications were rare after RF ablation in patients without other risk factors for systemic embolization, occurring in 4 of 558 right-sided procedures (0.7%) and in 3 of 272 left-sided procedures (1.1%). Moreover, three of these involved systemic venous thrombosis and were presumably unrelated to catheter manipulation within the heart. Conversely, in the same study, there were 6 cases of pericardial tamponade (0.6%), 20 cases of pericardial effusion (1.9%), and 32 cases of major bleeding/haematoma (3.05%).

In a single-centre study, intravenous heparin was administered with an initial bolus of 5000 U followed by 1000 U/h for the duration of the procedure in 376 patients undergoing right- and left-sided ablation. Neither warfarin nor aspirin was given after ablation. No embolic complication occurred, and deep vein thrombosis was observed in three patients (0.8%). However, cardiac tamponade occurred in three patients (0.8%) and one of them died. Pericardial effusion occurred in other three patients (0.8%).

**Anticoagulation vs. no anticoagulation**

In the Atakr prospective registry performed in 11 centres, anticoagulation protocols differed among centres for right-sided procedures: seven centres gave intravenous heparin during procedures, three did not, and one gave oral aspirin. Outpatient and post-procedure anticoagulation protocols also differed: five centres discharged patients on oral aspirin and six on nothing. Embolic complications could not be attributed to the use of anticoagulation either during or after the procedure, because a wide range of both inpatient and outpatient anticoagulation protocols were utilized and no single protocol was associated with a higher incidence of thrombo-embolic complications. Thakur et al.

**Recommendations for low-risk procedures**

Right-sided procedures (except AFL) are at low risk of thrombo-embolism during and after the procedure. Conversely, the risk of bleeding seems to be higher with anticoagulation. Therefore, anticoagulation therapy is not necessary for right-sided procedures (before, during, and after the procedure) unless other risk factors for systemic embolism are present.

<table>
<thead>
<tr>
<th>Complications</th>
<th>Warfarin (n = 767)</th>
<th>Aspirin (n = 1437)</th>
<th>None (n = 1184)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeding/haematoma</td>
<td>0.52%</td>
<td>1.04%</td>
<td>0.42%</td>
</tr>
<tr>
<td>Thrombotic events*</td>
<td>0.26%</td>
<td>0.39%</td>
<td>0.08%</td>
</tr>
</tbody>
</table>

*Thrombotic events considered: cerebral, deep vein thrombosis, and pulmonary.
procedure per se can be considered equal to that of the ‘low-risk’ procedures, as discussed previously.

In summary, as ablation in a patient with persistent common AFL presumably implies the restoration of sinus rhythm, there is a risk for procedure-related systemic embolism, not because of the procedure per se, but because of the underlying arrhythmic process, and that this risk extends for a period of time after the procedure.

Ablation for paroxysmal occasional common atrial flutter: ablation during sinus rhythm. If AFL is paroxysmal, the thrombo-embolic risk secondary to persistent AFL is not expected to be present at the time of the ablation procedure. Furthermore, no subsequent embolic risk is expected after the procedure, as there is no sinus rhythm recovery. As in the case of persistent AFL, the ablation procedure in itself is not expected to carry a significant risk for systemic embolism. Thus, the full ablation procedure can be considered equal to the ‘low-risk’ procedures, as discussed previously.

Left-sided interventions excluding atrial fibrillation and patients with overt structural heart disease

Several studies have shown that RF catheter ablation procedures carry some thrombo-embolic risk, despite the use of temperature feedback and different levels of prophylactic anticoagulation. A 10-year systematic review of the literature found a three-fold increase in the incidence of thrombo-embolic complications of left-sided RF ablation procedures (1.8–2%) when compared with an overall rate of only 0.6% when all ablation procedures are considered.1 Embolic events after LA ablation procedures were not included in this review.

The underlying mechanisms of a higher incidence in left-sided interventions are not clear. On the risk of systemic embolism associated with RF catheter ablation in the left heart, Hindricks2 reported an incidence of 0.46%, including cerebral embolism (0.4%) and peripheral arterial embolism (0.06%). In the particular case of RF procedures in left-sided accessory pathways, Thakur et al.53 reported the three late embolic complications in 153 patients (2%), despite the use of heparin during the procedure (activating clotting time >300 ms) and aspirin for 3 months after the ablation. In the Atakr registry study,42 two patients had a stroke (0.2%); one after the ablation of a left-sided accessory pathway with a transseptal approach and the other after the ablation of the AV junction with a retrograde aortic approach. Moreover, under the diagnosis of ‘thrombus/embolic event’ four more patients (0.4%) were included as major complications. Finally, the 1998 NASPE Prospective Catheter Ablation Registry reports no embolic events after the ablation of left free-wall accessory pathways in 418 patients.30

The differing anticoagulation protocols reported in these registries limit their conclusions and possible management recommendations. The incidence of embolic events after ablation procedures in patients with idiopathic left-sided VTs is unknown. The absence of significant structural heart disease in these patients suggests a lower incidence of events when compared with those with left ventricular dysfunction42 and similar to that observed in left-sided accessory pathway procedures. Other energy sources such as cryoenergy have showed the lower incidence of thrombus formation.46

At the current time, there is no scientific evidence that anticoagulant therapies prevent TEE in patients undergoing RF ablation procedures. Therefore, our recommendations are based on the experience of previous observational studies. However, systemic embolization consequences can be so devastating as to demand an antithrombotic therapy to decrease its risk, even if the rate of the embolic events is very low, as long as the haemorrhagic risk does not become prohibitive. In contrast, there is no clear relation between anticoagulation protocol and the incidence of bleeding complications in these procedures. However, an incidence of bleeding ranging from 2 to 3%42,50 brings us to consider anticoagulation protocols of intermediate intensity.

Recommendations for intermediate risk

Ablation for persistent common atrial flutter: ablation during flutter

In agreement with the previous discussion, with the ACC/AHA/ESC 2006 Guidelines for the management of patients with AF, and with the ACC/AHA/ESC Guidelines for the management of patients with supraventricular arrhythmias, we recommend that antithrombotic therapy is undertaken before, during, and after the ablation procedure. The following protocol is proposed:

- Effective anti-vitamin K anticoagulation for 3 weeks or TOE screening prior to the ablation procedure.
- Stop anti-vitamin K for 2–5 days before the ablation procedure. Bridging therapy with heparin until the day before the ablation procedure is recommended.
- Sodium heparin during (or immediately after) the ablation procedure, at doses of a bolus of 5000 and 1000 U/h is recommended, although evidence for this practice is lacking.
- Re-start effective anticoagulation for 4 weeks after the ablation procedure. Minimize the window of ineffective anticoagulation.

Ablation for paroxysmal occasional common atrial flutter: ablation during sinus rhythm

In patients without a conventional indication for anticoagulation, follow previous recommendations for low-risk procedures.

Left-sided interventions excluding atrial fibrillation and patients with overt structural heart disease

Anticoagulation therapy prior to the intervention is not advised in this clinical setting. Intravenous sodium heparin is recommended during the ablation procedure, immediately after arterial access at doses of a bolus of 5000 U/h followed by 1000 U/h during the procedure. Other more aggressive anticoagulation regimens may also be considered in the individual cases such as those undergoing complex, long procedures, and extensive RF applications.

High-risk procedures

Atrial fibrillation ablation

Thrombo-embolic complications reported that incidence is higher when the RF ablation is performed in systemic chambers (1.8–2%).1 The ablation of AF bears a risk of thrombo-embolic complication that is inherent to the procedure and has been reported in up to 5% of the patients.8 In a worldwide survey on efficacy and safety of the RF ablation for human AF,7 including 8745 patients, 4 early deaths were reported in which 2 of them resulting from massive
cerebral thrombo-embolism. The reported risk of non-fatal stroke was 0.28%, and transient ischaemic attacks were observed in 0.66% of the patients. In another large series of AF ablation,10 thrombo-embolism occurred in 1.1% of the patients, 0.9% of which were observed within 2 weeks of the procedure, despite the use of low-molecular-weight heparin in half of these patients. In all patients, INR levels were sub-therapeutic. Late thrombo-embolism occurred in 0.2% of the patients 6–10 months after the procedure, despite therapeutic INR. Half of these patients had recurrence of AF.

In a large non-randomized study comparing RF ablation of AF with anti-arrhythmic drug therapy,10 no thrombo-embolic complication was observed in the peri-procedure period. Late thrombo-embolism occurred more frequently in medically treated patients (10 vs. 2.5% in the ablated patients) and was associated with a higher recurrence of AF (58 vs. 20%). Thus, these results seem to underestimate the true incidence of thrombus formation that might result in sub-clinical events. Results of a study performed with intracardiac echocardiography seem to report thrombus formation in more than 10% of the patients.10 In 90% of the patients, the thrombus could be withdrawn into the right atrium by pulling back the sheath and the mapping catheter. In the remaining patients, the thrombus was wedged in the inter-atrial septum and was incompletely withdrawn in the right atrium or was only recognized on post-procedure review of intracardiac images. None of these patients had any neurological complaint following the procedure.

In the absence of prospective and multicentre evidence, it is not possible to formulate precise recommendations. Nevertheless, a cohort of basic recommendations are summarized below, based on pathophysiological considerations, single-centre experiences, and consensus.

Minimize or eliminate the generation of thrombi during the procedure

Intravenous heparin administration, an adjunctive continuous heparinized flush, and correct technique to aspirate and flush sheaths placed on the systemic side of the circulation are the bare minimum measures necessary during the procedure. Additionally, intracardiac echocardiography monitors the development of thrombi (and perhaps micro-bubble formation) and may help reduce the thromb-embolic complication rate, particularly if an external irrigated-tip catheter is not used for ablation. Maintaining electrode temperatures as low as possible, preferably with external irrigation, helps reduce the formation of soft coagulum and char. Simple measures such as ensuring a continuous (100–200 cc/h) heparinized flush through the side-arm of all systemic sheaths (to be maintained despite catheter exchange), withdrawing the sheath into the right atrium after introducing the ablation or circular pulmonary veins mapping catheter into the left atrium, and minimizing the procedure and ablation times should be widely adopted.

Unresolved issues remain such as the appropriate intensity of heparin anticoagulation during the procedure, which has varied from one laboratory to another—ranging from an ACT target of 200 to 400 s and even to no ACT monitoring. A related issue is the timing of institution of heparin therapy, indeed; although most physicians administer heparin after the confirmation of the LA access, there are advocates of administration even before transseptal puncture.

Minimize or eliminate thrombus generation following the procedure

The aim of anticoagulation management during this phase is to permit a smooth transition, which allows uncomplicated free sheath removal while at the same time ensures minimal interruption of effective anticoagulation. Although published details are limited, heparin is usually withheld for a fixed period (1–4 h) or till the ACT declines to 150 s and sheaths are removed. Although the risk of haemorrhagic complications—local and delayed tamponade—is elevated during the first 12–24 h post-procedure, intravenous heparin is preferred to fractionated heparin during this period in view of unfractionated heparin’s shorter half-life, ability to monitor its effect rapidly with bedside ACT or prothrombin time (PTT), and ability to antagonize with protamine.

Haemostasis after arterial sheath removal requires careful attention to anticoagulation intensity, and some physicians get around this problem by either avoiding arterial puncture or by placing a thin gauge cannula only sufficient for pressure monitoring. The practice of protamine reversal should be discouraged, although there may not be much choice in the rare event of tamponade.

Therapeutically effective levels of anticoagulation are maintained with intravenous heparin till the following day and then replaced with fractionated heparin. Oral anticoagulation is started on the evening of the procedure, and weight-adjusted fractionated heparin continued till an INR > 2 is achieved.
Ventricular tachycardia ablation associated with structural heart disease

Radiofrequency ablation can be applied in the treatment of VT in patients with left ventricular dysfunction because of prior myocardial infarction,75–77 dilated cardiomyopathy,78,79 bundle branch re-entry,80,81 and various forms of idiopathic VT.82 Although the risk of thrombo-embolic complications associated with left-sided ablations can be as high as 2.8%,83 there are no recommendations with regard to anticoagulation in left-sided VT.

In most studies of VT ablation, heparin infusion of 1000 U/h is administered after the insertion of sheath preceded by a bolus of at least 5000 U, with no ACT monitoring during the procedure.76,83–85 Other authors performed ACT monitoring during the procedure with the target values of 200–250 s.77,86

Although many—if not all—considerations offered for ablation of AF hold true for left-sided VT, the access route is usually arterial with retrograde crossing of the aortic valve with a bare catheter into a high pressure LV in contrast to a transseptal access into the low pressure LA through a long sheath. As a result, a sheath is used only for a transseptal, transmural access to the LV and then it would be wise to use the same precautions as for AF procedures.

Echocardiographic screening is necessary to rule out the presence of intracardiac thrombus, particularly within the LV. Transoesophageal echocardiography generally provides sub-optimal images of the LV, particularly its apical region.

Recommendations for catheter ablation of atrial fibrillation

Warfarin for at least 4 weeks prior to the ablation procedure.

Stop warfarin 4–5 days before the ablation procedure. Bridging therapy with heparin (either low-molecular-weight heparin or unfractionated heparin) until the day before the ablation procedure.

Peri-procedure anticoagulation

After sheath insertion and transseptal puncture, administration of a bolus of IV heparin (bolus dose empirically 5000–10000 U or 50–100 U/kg) followed by continuous infusion of 1000–1500 U/h in order to achieve ACT at least in excess of 300 s is checked every 30–45 min. At the completion of the procedure, IV heparin is discontinued and sheaths removed when the ACT is sub-therapeutic (<160 s). IV heparin to be resumed for 12–24 h at a maintenance dose of 1000 U/h without a bolus that will maintain a PTT at 60–80 s or at least twice the baseline level. Oral anticoagulation to be resumed the day of the procedure.

Replace IV heparin with subcutaneous low-molecular-weight heparin after 12–24 h.

Stop low-molecular-weight heparin when the target INR2–3 is reached.

Continue therapeutic warfarin as per original indication (but at least for 1 month).

In the absence of prior indication for warfarin, peri-procedure anticoagulation as above followed by fractionated heparin or IV heparin for 12–24 h and aspirin thereafter (80–325 mg/day) for at least 1 month.

Table 2 shows venous thrombosis and complications associated with vascular access. Although complications because of vascular access are inevitably associated with invasive electrophysiological procedures, no randomized study comparing the effects of various anticoagulation regimens or local approach with the catheterization site has, to the best of our knowledge, been published. The clinical practice has evolved with little scientific evidence. Complications reported from a few studies are summarized in Table 3. The overall rate of vascular access-related complications ranges from 0.01 to 4%.80,81

A significantly higher complication rate has been reported in the elderly (>65 years old) than in young patients undergoing electrophysiological study (2.2 vs. 0.5%, P = 0.0002) or RF ablation (6.1 vs. 2.0%, P = 0.0015).89

The incidence of vascular complications depends on several factors: type of vascular access (arterial, venous, or both), site of vascular access (i.e., femoral vs. subclavian or jugular), number of introduced catheters, length of the procedure, patient’s profile (i.e., obesity and baseline coagulation parameters), type of anticoagulation used, management of catheterization site during the procedure (i.e., flush) and afterwards (immediate vs. delayed catheter removal, duration and strength of compression, and use of protamine), and operator experience.

Venous haematoma and thrombosis

The most frequent complications associated with venous access are significant haematoma and venous thrombosis (18 of 11258 procedures, Table 1). Despite the lack of supporting data, the introduction of two sheaths through one puncture site probably increases the risk of haematoma, as does the use of wide-calibre sheaths for several simultaneous catheters.

In children, the rate of femoral vein occlusion may be high, reaching 22% as documented by magnetic resonance angiography, despite the administration of intravenous heparin. However, all the cases were asymptomatic.91 Also, detailed ultrasonography revealed a surprisingly high rate of non-occlusive deep vein thrombosis in adults (18%), which resolved in all but one patient within 1 week after the procedure.92 This study also showed that the local complication rate was not associated with the number of introduced catheters or such clinical variables as age,
Despite the high incidence of silent occlusion of a punctured femoral vein, clinical pulmonary embolism is infrequent (1 of 11,258 procedures, Table 1). However, there may be a great number of sub-clinical emboli, the consequences of which are unknown.

Complications due to arterial puncture

The most frequent complication associated with arterial access is haematoma, followed by pseudoaneurysm and arterio-venous fistula. Dangas et al.\textsuperscript{93} reported an incidence of 5.1% vascular complications with standard femoral compression. In a systematic literature search, arterial puncture closing devices appeared to be effective in terms of reducing time to haemostasis; however, looking at the studies such as haematoma and pseudoaneurysm formation occurred more often when devices were used.\textsuperscript{94} A pseudoaneurysm occurs in 0.8–2.2% of the patients after interventional procedures.\textsuperscript{95} Ultrasound-guided compression has replaced the need for surgical repair of femoral artery pseudoaneurysms in some cases. Also, thrombin injections can close the aneurysm.\textsuperscript{96} Arterio-venous fistula (2 of 9813 patients).

### Table 2

Data from the literature on vascular complications associated with catheterization site (11,258 procedures in 9,813 patients)

<table>
<thead>
<tr>
<th>Study</th>
<th>Population studied</th>
<th>Anti-coagulation protocol</th>
<th>Overall complication rate</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kihel et al.\textsuperscript{87}</td>
<td>276 elderly–AVNRT ablation</td>
<td>Heparin bolus 2500 U, then 1000 U/h</td>
<td>4 (1.4%)</td>
<td>Deep vein thrombosis with pulmonary embolism (n = 1) and groin haematoma (n = 3); arterial haematoma (n = 3); venous thrombosis (n = 8); femoral pseudoaneurysm (n = 1); arterio-venous fistula (n = 1); and infection (n = 1)</td>
</tr>
<tr>
<td>Arch Mal Coeur Vaiss\textsuperscript{88}</td>
<td>2,765 patients–various ablation procedures</td>
<td>Various</td>
<td>19 (0.3%)</td>
<td>Pneumothorax (n = 1); arterial haematoma (n = 3); venous thrombosis (n = 8); femoral pseudoaneurysm (n = 1); arterio-venous fistula (n = 1); and infection (n = 1)</td>
</tr>
<tr>
<td>Cheema et al.\textsuperscript{89}</td>
<td>64 patients–AF ablation</td>
<td>Heparin infusion to achieve ACT &gt; 350 s</td>
<td>3 (4%)</td>
<td>Pseudoaneurysm (n = 2) and arterio-venous fistula (n = 1)</td>
</tr>
<tr>
<td>Chen et al.\textsuperscript{90}</td>
<td>2,593 patients–3966 various ablation or diagnostic EP procedures</td>
<td>Left-sided: heparin bolus 5000 U, then 1000 U/h, reversed by protamine at the end. Right-sided: no heparin</td>
<td>12 (0.4%)</td>
<td>Aortic dissection (n = 2); femoral artery thrombosis (n = 3); deep vein thrombosis (n = 1); significant haematoma (n = 2)</td>
</tr>
<tr>
<td>Epstein et al.\textsuperscript{91}</td>
<td>758 patients–830 procedures (WPW or AVNRT/a-v nodal ablations)</td>
<td>Various</td>
<td>3 (0.04%)</td>
<td>Venous thrombosis (n = 3)</td>
</tr>
<tr>
<td>Scheinman and Huang\textsuperscript{50}</td>
<td>3,357 procedures</td>
<td>Various</td>
<td>0.01%</td>
<td>Two pneumothorax and one pseudoaneurysm</td>
</tr>
</tbody>
</table>
Anticoagulation may also be considered on an individual basis, particularly for long procedures. Reversal of anticoagulation before catheter removal has been suggested in some reports, but no randomized study was performed to clarify this issue.

**Recommendations**

**Prevention of venous thrombosis:**
- the use of intravenous heparin can be individualized as discussed elsewhere in the document; however, in patients with a history of distal venous thrombosis (DVT), heparin is indicated;
- only light compression at the puncture site and rapid patient’s mobilization (4–6 h);
- flushing of sheaths with heparin;
- draining back blood through sheaths before sheaths withdrawal in order to prevent thrombus migration from sheath to the femoral vein;
- limiting the number of femoral vein or artery sheaths on the same side.

**Prevention of arterial complications:**
- bleeding—proper compression or angioseal as after coronary angiography and avoidance of excessive anticoagulation;
- prevention of false aneurysm or arterio-venous fistula—proper puncture technique and proper compression after sheath removal.

**Special situations**

**Electrophysiological study and ablation in infants and children**

Invasive EPS and catheter ablation in infants or children are rare, but increasing in number and anticoagulation regimen needs to be addressed. The problem with this population is that among infants and children, there is a large heterogeneity with respect to underlying heart disease, body weight, and size. There are different aspects regarding anticoagulation such as risk of cardiac perforation, bleeding, and risk of thrombo-embolism. Furthermore, when compared with adults there is an increasing risk of arterial occlusion or venous thrombosis because of the discordance between smaller vessel diameter and catheter size.

There are data from the Pediatric RF Catheter Ablation Registry that provide an overview on the general risk of complications, although there is no information on the anticoagulation protocol used. The risk of emboli or thrombi was 6/3187 for ablation of supra-VT in the new era. Unfortunately, the risk of bleeding was not mentioned.

In the Report of the Seventh ACCP Conference on Antithrombotic and thrombolytic therapy, published in 2004, the following recommendations for thromboprophylaxis in diagnostic cardiac catheterization in neonates and children are given:

- For neonates and children requiring cardiac catheterization via an artery, IV heparin prophylaxis is recommended (Grade 1A).
- It is suggested to use heparin doses of 100–150 U/kg as a bolus. Further doses may be required in prolonged procedures (both Grade 2B).
In this report, it is referred to neonates as infants from birth to 28 days of age corrected for gestational age and to children as from 28 days of age to 16 years.

When a left-sided ablation is performed, the administration of heparin is weight-adjusted and targeted at an effective anticoagulation as in adults to avoid thrombo-embolism. Differences in heparin effects depending on the age have to been taken into account. It can be summarized that in contrast to adults or adolescents, the risk of arterial occlusion or venous thrombosis has to be considered because of vessel/sheath and electrode-mismatch in children and infants.

Electrophysiological study and ablation in patients requiring permanent anticoagulation

Electrophysiological study and/or catheter ablation in patients with the need for permanent anticoagulation is a relevant and frequent setting in every day practice. All patients with mechanical heart valves, AF and relevant additional risk factors, and LA or left ventricular thrombus will need effective anticoagulation before and after the procedure.

The thrombo-embolic risk for interventions on the right side such as AFL, atrial, or junctional tachycardias is very low (discussed earlier). However, there are no specific data on patients who require permanent anticoagulation.

Recommendations

For neonates and children requiring diagnostic cardiac catheterization via an artery intravenous heparin prophylaxis is recommended. It is suggested to use heparin at 100–150 U/kg as a bolus. Further doses may be required in prolonged procedures.

When a left-sided ablation is performed, the administration of heparin is weight-adjusted and targeted at an effective level as in adults to avoid thrombo-embolism.

For exclusively transvenous approaches, no specific recommendations are given.

Electrophysiological study and ablation in patients with clopidogrel and aspirin

With the increasing use of intracoronary stents and especially drug-eluting stents, the issue of anticoagulation and invasive electrophysiological study and catheter ablation is certainly increasing. There are two different problems: the risk of peripheral bleeding and the risk of cardiac tamponade due to cardiac perforation. Although both agents cannot be adequately antagonized, a question of whether the risk of bleeding and the outcome of cardiac tamponade are different when the patient is on both drugs.

For the introduction and manoeuvring of the sheaths and catheters, the risk of peripheral bleeding or complications when using aspirin and clopidogrel is low. In a large prospective trial on the use of clopidogrel and aspirin for the prevention of stent thrombosis after coronary intervention, the risk of major bleeding was 0.6% and the risk of vascular complication was 0.5%. In all these interventions, additional use of effective unfractionated heparin was present and presumably adds to the risk of bleeding so that the risk in electrophysiology or approaches without heparin is probably lower.

Thus, the risk for left-sided electrophysiological procedures should be no larger than this. In reality, the general risk of vascular complications during or after ablation in the Spanish EP registry is 0.37% in 6162 ablations. On the basis of these data, regarding vascular complications, the use of clopidogrel should not be a relevant issue. With respect to the left-sided approaches, the bleeding risk should be comparable with coronary interventions, because usually only one femoral arterial sheath with 6–8 Fr diameter is used when compared with coronary interventions.

The other problem may be the management of cardiac tamponade or pericardial effusion because of perforation when the patient is on aspirin and clopidogrel. Again, there are no relevant data in the literature on this specific question and therefore no definite answer can be given. However, the risk of perforation in right-sided catheter ablation is certainly extremely low and for left-sided interventions also (except in the ablation of AF which carries higher incidences of tamponade). It can be assumed that bleeding is more severe and more difficult to be managed when the patient is on aspirin and clopidogrel.

Recommendations

Right-sided procedures and uncomplicated left-sided procedures, such as ablation of accessory pathways, can be performed with a low risk.

Ablation of AF should not be performed in patients on aspirin and clopidogrel because of an increased risk of major bleeding secondary to cardiac tamponade.

In these cases, ablation should be postponed to a time when aspirin and clopidogrel can be safely discontinued.

Conflict of interest: none declared.

References

Consensus document on antithrombotic therapy


