Periprocedural Anticoagulation of Patients Undergoing Pericardiocentesis for Cardiac Tamponade Complicating Catheter Ablation of Atrial Fibrillation

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SUMMARY

Anticoagulation of patients with cardiac tamponade (CT) complicating catheter ablation of atrial fibrillation (AF) is an ongoing problem. The aim of this study was to survey the clinical practice of periprocedural anticoagulation in such patients. This study analyzed the periprocedural anticoagulation of 17 patients with CT complicating AF ablation. Emergent pericardiocentesis was performed once CT was confirmed. The mean drained volume was 410.0 ± 194.1 mL. Protamine sulfate was administered to neutralize heparin (1 mg neutralizes 100 units heparin) in 11 patients with persistent pericardial bleeding and vitamin K1 (10 mg) was given to reverse warfarin in 3 patients with supratherapeutic INR (INR > 2.1). Drainage catheters were removed 12 hours after echocardiography confirmed absence of intrapericardial bleeding and anticoagulation therapy was restored 12 hours after removing the catheter. Fifteen patients took oral warfarin and 10 of them were given subcutaneous injection of LMWH (1 mg/kg, twice daily) as a bridge to resumption of systemic anticoagulation with warfarin. Two patients with a small amount of persistent pericardial effusion were given LMWH on days 5 and 13, and warfarin on days 6 and 24. The dosage of warfarin was adjusted to keep the INR within 2-3 in all patients. After 12 months of follow-up, all patients had no neurological events and no occurrence of delayed CT. The results showed that it was effective and safe to resume anticoagulation therapy 12 hours after removal of the drainage catheter. This may help to prevent thromboembolic events following catheter ablation of AF. (Int Heart J 2015; 56: 56-61)

Key words: Atrial tachyarrhythmia, Pericardial haemorrhage, Warfarin

Radiofrequency catheter ablation (RFCA) has been proposed as a promising technique to treat atrial fibrillation (AF).¹⁾ Cardiac tamponade (CT) is the most common potentially life threatening complication associated with AF ablation. CT occurs in 0.1–2% of the patients undergoing RFCA of AF in experienced centers.²⁾ Pericardial drainage is usually performed in patients with CT.³⁾ Effective anticoagulation before, during, and after AF ablation procedure is always required to prevent thrombotic events, but it may increase the risk of recurrence of hemopericardium and tamponade.⁴⁾ On the one hand, patients with CT require the cessation of anticoagulation therapy and need hemostatic therapy. On the other hand, patients undergoing RFCA of AF should continue anticoagulation therapy after an ablation procedure to prevent thromboembolism.⁵⁾ How and when should effective anticoagulation therapy be given to patients with CT complicating RFCA of AF are difficult clinical decisions. Few data are available concerning the optimal approach to anticoagulation following pericardial drainage. The aim of this study was to sur-

vey clinical practices and outcomes of anticoagulation strategy in such cases at our center.

METHODS

We performed a retrospective analysis of 3,187 cases undertaken at our center for RFCA of drug-refractory AF between January 2007 and December 2012. Of the 3,187 patients, 17 who underwent pericardial drainage for CT complicating AF ablation were enrolled. Three patients with CT, in whom percutaneous pericardial drainage failed and required emergency open-chest surgery, were excluded.

Ablation protocol: A transesophageal echocardiogram was performed to exclude thrombus in the left atrium. Those patients with a therapeutic international normal rate (INR) of 2-3 continued oral warfarin before ablation. Subcutaneous injection of low molecular weight heparin (LMWH, 1 mg/kg twice, daily) was administered and stopped 12 hours before ablation

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This study was supported by grants from the “Twelfth Five Year” National Science and Technology Support Program of China (No. 2012BAI14B0) and Beijing City Board of Education Technology Development Project (No. KZ201210025030).

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Received for publication May 15, 2014. Revised and accepted June 13, 2014.

Released in advance online on J-STAGE December 11, 2014.

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if the INR value did not reach 2-3 or the patients never took oral warfarin.

Single transeptal puncture performed under fluoroscopic guidance and circumferential pulmonary vein ablation (CPVA) guided by the Carto system (Biosense Webster, Inc., Diamond Bar, CA, USA) were essential for all AF ablation procedures at our center. For patients with persistent AF, additional ablation lines were created along the left atrial roof, mitral isthmus, and cavotricuspid isthmus. Further complex fractionated atrial electrogram (CFAE) ablation and cardioversion were performed if sinus rhythm could not be restored by the above ablation procedure. The endpoint of the procedure included pulmonary vein electrical isolation, bidirectional conduction block of the additional lines, and non-inducibility of any sustained atrial tachyarrhythmia.^{6,7)} Intravenous heparin was used to maintain an activated clotting time (ACT) of at least 300 seconds after transeptal puncture.

Pericardiocentesis and anticoagulation protocol: CT was suspected if patients had dyspnea, nausea, vomiting, vertigo, and/or a drop in systolic blood pressure to < 90 mmHg, and the diagnosis was made if a non-pulsating cardiac border and an epicardial halo were observed on fluoroscopy or confirmed by echocardiography. Emergent fluoroscopy-guided pericardial puncture was performed. A pigtail catheter was placed in the pericardial space. Pericardial fluid was drawn out via the pigtail catheter and direct retransfusion of the pericardial blood via a femoral venous sheath was performed. Protamine sulfate was administered to reverse heparin and Vitamin K1 was used to reverse supratherapeutic INR if necessary. The drainage catheter was removed when the hemodynamic status remained stable and echocardiographic findings confirmed there was no recurrence of pericardial effusion 12 hours after percutaneous drainage. Warfarin was reinitiated and LMWH was used as a bridge to resumption of INR 2-3. During the period of follow-up, oral warfarin was discontinued after 3 months if no AF recurrence was observed in patients with a CHADS₂ score < 2.

The patients who had at least one cardiovascular risk factor, such as coronary artery disease, hypertension, diabetes mellitus, or smoking, were switched to antiplatelet treatment (aspirin 100 mg/day).

Follow-up: All patients were followed up at 1, 3, 6, 9, and 12 months after discharge. They were monitored by means of outpatient clinical examinations, ECG, and 24-hour Holter monitoring during each visit. All patients contacted the hospital anytime they perceived symptoms potentially related to arrhythmia relapse. Those patients with recurrence of at least 30 seconds of atrial arrhythmias including AF and atrial tachyarrhythmia 3 months after the procedure were regarded as recurrent cases. Freedom from atrial arrhythmias with or without antiarrhythmic drug therapy, death, stroke, and complications were registered.

Statistical analysis: Statistical analysis was performed with SPSS for Windows (Microsoft, Redmond, WA, USA) version 13.0 (SPSS Inc, Chicago, IL). Continuous variables are presented as the mean $\pm$ standard deviation (SD) and were compared using the paired samples *t*-test. A value less than 0.05 was considered statistically significant.

RESULTS

Patient characteristics: Of the 3187 patients undergoing RFCA of AF, 17 (0.53%) who received pericardial drainage for CT were included in this analysis and 12 (70.6%) were male. The average age of these patients was 63.3 ± 9.3 years. There were 4 patients with CHADS₂ ≥ 2 . The baseline characteristics of the patients are shown in Table I.

Results of pericardial drainage for CT: In the present study, 14 patients developed CT in the catheterization laboratory where an emergent fluoroscopy-guided pericardial puncture was performed and pericardial fluid was drawn out. A mean of 410.0 ± 194.1 mL of blood was drained from the pericardium

Table I. Baseline Characteristics

Case	Gender/age	Type of AF	CHADS ₂ score	Comorbidities	LA Diameter of AP (mm)	Warfarin dosage (mg)	Subcutaneous injection LMWH (1 mg/kg)
1	M/59	ParAF	0	HBP DM	39	4.5	twice daily
2	M/50	ParAF	0	—	40	5	twice daily
3	M/66	PerAF	1	HBP MG	45	2.75	—
4	F/62	ParAF	0	—	35	—	twice daily
5	M/59	ParAF	0	—	36	3	twice daily
6	F/85	PerAF	3	BA	47	2.5	—
7	M/68	PerAF	1	—	35	3	twice daily
8	M/60	ParAF	0	HBP CHD	29	—	twice daily
9	F/58	ParAF	0	—	34	—	twice daily
10	M/67	ParAF	0	HBP	30	—	twice daily
11	M/62	ParAF	0	FL	42	—	twice daily
12	F/60	ParAF	0	HBP	39	—	twice daily
13	M/50	ParAF	0	—	47	—	twice daily
14	M/73	PerAF	2	HBP	46	—	twice daily
15	M/58	PerAF	4	HBP TIA	39	—	twice daily
16	F/80	PerAF	5	HBP DM	38	—	twice daily
17	M/59	PerAF	1	HBP	38	3	—

AF indicates atrial fibrillation; ParAF, paroxysmal AF; PerAF, persistent AF; LA, left atrial; AP, anteroposterior; HBP, high blood pressure; DM, diabetes mellitus; CHD, coronary heart disease; MG, Myasthenia gravis; BA, bronchial asthma; FL, fatty liver; TIA, transient ischemic attack; LMWH, low-molecular weight heparin; and INR, international normalized ratio.

and 12 patients had an immediate autotransfusion (mean volume 311.3 ± 129.0 mL). Three patients developed CT in the ward. Patient 12 (Table II) was hemodynamically unstable 10 hours after ablation and emergency pericardial drainage was performed at bedside where 285 mL of blood was drawn out and then the patient was transferred to the catheterization laboratory where an additional 200 mL of blood was withdrawn. If persistent pericardial bleeding occurred, protamine sulfate (1 mg neutralizes 100 units of heparin) was administered intravenously to neutralize heparin in 11 patients. Three patients with supratherapeutic INR ($\text{INR} > 2.1$) received 10 mg vitamin K1 intravenously. The results are presented in Table II.

Timing of anticoagulant resumption: Once CT was confirmed, the anticoagulation therapy (oral warfarin and/or subcutaneous LMWH) was discontinued. Drainage catheters were

removed 12 hours after echocardiography confirmed the absence of intrapericardial bleeding and anticoagulation therapy was restored 12 hours after removing the catheter. Oral warfarin was restored (the doses were the same as before) in 3 patients with a therapeutic INR value (2-3). Fourteen patients without a therapeutic INR value (< 2) before the ablation procedure were administered LMWH (1 mg/kg, twice daily) as a bridge to resumption of systemic anticoagulation with warfarin. In addition, patients 4 and 9 (Table III) with a small amount of pericardial effusion reaccumulation underwent daily echocardiographic examinations and anticoagulation therapy was not restored until no more pericardial fluid was observed again. The outcomes are shown in Table III.

Clinical outcomes: All patients in this study were followed up for 12 months. After a 3-month blank period, 3 patients with

Table II. Procedural Parameters

Case	INR before CT	ACT before CT	Fluid removed (mL)	Autotransfusion (mL)	Protamine /vit K1 (mg)	ACT after PD
1	0.92	330	200	200	—	275
2	0.99	410	360	—	—	290
3	1.43	360	600	500	25	215
4	0.89	310	580	—	25	200
5	2.03	320	280	280	25	185
6	2.9	440	310	310	50/10	245
7	2.57	310	840	—	25/10	174
8	1.01	330	300	80	—	265
9	1.13	420	150	—	—	290
10	0.97	470	150	150	37.5	180
11	1.02	320	270	—	—	280
12	0.9	330	485	300	—	275
13	1.04	340	450	300	25	240
14	1.66	370	435	415	50	126
15	1.34	300	330	300	25	160
16	0.91	310	700	500	25	145
17	2.85	330	530	400	25/10	175

INR indicates international normalized ratio; CT, cardiac tamponade; ACT, activated clotting time; vit K1, vitamin K1; and PD, pericardial drainage

Table III. Postoperative Management and Outcome

Case	INR before removing drainage catheter	Time of LMWH (1 mg/kg, BID) after PD	Time/dosage of warfarin (mg) after PD	INR one month later	AF recurrence Six months later
1	1.66	12 hours	12 hours /4.5	1.88	+
2	1.68	—	12 hours /5	2.81	—
3	1.57	—	12 hours /2.75	2.68	—
4	0.89	5 days later	6 day later /3	1.81	—
5	0.91	12 hours	24 hours /3	2.63	+
6	2.01	—	12 hours /2.5	2.42	+
7	1.3	12 hours	48 hours /3	1.95	+
8	1.01	12 hours	48 hours /3	2.02	—
9	1.13	13 days later	24 days later /3	1.42	—
10	0.97	12 hours	24 hours /3	2.13	—
11	1.02	12 hours	24 hours /3	2.15	—
12	0.9	12 hours	24 hours /3	0.93	—
13	1.04	12 hours	24 hours /3	2.01	—
14	0.92	12 hours	24 hours /3	2.22	+
15	1.34	12 hours	24 hours /3	2.10	+
16	1.33	12 hours	48 hours /3	1.80	—
17	1.85	12 hours	12 hours /3	2.35	+

INR indicates international normalized ratio; LMWH, low-molecular weight heparin; and PD, pericardial drainage.

AF recurrence and CHADS₂ score ≥ 2 continued oral warfarin and their INR values were maintained between 2-3. In contrast, 9 patients with CHADS₂ score < 2 stopped taking oral warfarin. Five patients with a history of hypertension were given oral aspirin instead (100 mg/day) and one of them was administered clopidogrel (75 mg/day) simultaneously because he had undergone coronary artery stent implantation 9 months previously. After 12 months of follow-up, no patient had a neurological event (embolism or stroke) or the occurrence of delayed CT. The outcomes are shown in Table III.

DISCUSSION

For patients with CT complicating AF ablation, pericardial bleeding is associated with a significant risk of death, and anticoagulation will aggravate hemopericardium and pericardial tamponade.⁸⁾ Risk assessment in these patients receiving RFCA of AF should address the risk of both thrombotic and bleeding complications. Prevention of bleeding is as important as preventing thrombotic events.⁹⁾ Severe hemorrhage requires the interruption and neutralization of antithrombotic treatment. Thus, anticoagulation therapy should be stopped and hemostatic therapy initiated in these patients.¹⁰⁾ However, a strategy that interrupts anticoagulation clearly puts the patient at risk for stroke.¹¹⁾ Anticoagulation management for these patients is a difficult problem and few data are available concerning this issue. The results of this study showed that after emergency percutaneous drainage and reversal of anticoagulation, it was safe to remove the drainage catheters 12 hours later as no more fluid was found in the pericardium and that effective anticoagulant therapy could be restored 12 hours after removing the catheter.

The treatment of CT involves not only the control of hemodynamic abnormalities but also the reversal of anticoagulation.¹²⁾ Protamine sulfate is a positively charged polypeptide widely used to reverse heparin induced anticoagulation.¹³⁾ In this study, after pericardial drainage, protamine sulfate needed to be administered to reverse the effects of heparin in the event of persistent pericardial bleeding. The dose of protamine sulfate (1 mg neutralizes 100 units of heparin) was based on the heparin dose used during the procedure. If the bleeding continues, a second injection of protamine sulfate can be given; this dose of protamine sulfate should be half that of the first.¹⁴⁾

Management of urgent reversal of the effect of warfarin should be individualized and depends on the severity of the hemorrhage and the INR value when bleeding occurs.¹⁵⁾ Vitamin K is a useful agent for reversing supratherapeutic INR in patients who have active bleeding or require invasive procedures.¹⁶⁾ Hanslik, *et al* confirmed that the use of vitamin K in patients with warfarin over-anticoagulation lowers excessively elevated INR faster than withholding warfarin alone.¹⁷⁾ Willms, *et al* found that low-intensity warfarin (INR 1.5–2.1) was safe and effective to reduce the likelihood of major hemorrhagic or ischemic events in patients with non-valvular AF during the perioperative period.¹⁸⁾ Therefore, we used vitamin K to lower the supratherapeutic INR (INR value > 2.1) rapidly after pericardial drainage to minimize the risk of continued pericardial bleeding.¹⁹⁾ Intravenous administration of vitamin K has a slight risk of severe anaphylactoid reaction and should only be given by slow intravenous infusion (over 20-30 minutes) and

more rapid reversal is achieved.²⁰⁾ This mode of vitamin K administration in case of emergency is widely adopted throughout the world, including at our center. In the present study, the majority of episodes of CT could be managed successfully by immediate drainage and reversal of anticoagulation with protamine sulfate (11 patients) and vitamin K1 intravenously (3 patients) simultaneously.

Warfarin was previously the only option for oral anticoagulation, but new oral anticoagulants such as dabigatran have become available as alternatives for warfarin in the periprocedural period for RFCA of AF. Dabigatran has demonstrated improved efficacy compared with warfarin. The advantages of dabigatran include a rapid onset, predictable pharmacokinetics, and no need for routine anticoagulation monitoring.²¹⁾ However, a limitation to the use of dabigatran is that in cases of cardiac tamponade or excessive bleeding, there is no specific antidote at present. The use of fresh frozen plasma, prothrombin complex concentrates, or hemodialysis might be helpful.²²⁾ We had no experience with new oral anticoagulants for patients who underwent pericardial drainage for CT complicating AF ablation. The management of anticoagulation in such patients needs further investigation.

Patients undergoing RFCA of AF require postprocedural anticoagulation to minimize thromboembolic complications because the ablation procedure leaves patients with substantial areas of damaged LA endothelium that may become a nidus for thrombus formation.²³⁾ The atrial tissue may be stunned for several weeks or even months, which is also an important factor for thrombus formation.²⁴⁾ Thus, it is necessary for those patients to continue anticoagulation therapy after RFCA of AF to prevent thromboembolism.²⁵⁾ However, for patients with CT complicating AF ablation, the questions of whether to restart anticoagulant therapy and how long to wait before doing so are difficult clinical decisions. In order to avoid thromboembolic complications, Christian, *et al* suggested that for patients with acute coronary syndromes and severe bleeding complications, antiplatelet and/or anticoagulation agents should not be reintroduced until strict control of the hemorrhage has been obtained for at least 24 hours.²⁶⁾ But for patients with CT complicating AF ablation, the risk of interrupting antithrombotic agents must be weighed against the risk of a thrombotic event.^{27,28)} In this study, our management was that the drainage catheters were removed 12 hours after no more fluid was seen in the pericardium and effective anticoagulation therapy was restored 12 hours after removing the draining catheter. All patients were given oral warfarin after RFCA of AF for a 3-month blank period.

In order to prevent delayed CT, the management of anticoagulation encompasses the choice of safer drugs, appropriate dosage, reduced duration of antithrombotic treatment, and use of antiplatelet agents according to proven indications (taking into account CHADS₂ score).^{29,31)} In the present series, those patients with AF recurrence and a CHADS₂ score ≥ 2 continued the oral warfarin after three months, while the others were given antiplatelet treatment instead. More attention must be paid to achieving the optimal safe level of anticoagulation throughout the process. Strict control of target INR 2-3 was the goal for patients who required continuous warfarin treatment.³²⁾ The results of this study showed that after 6 months of follow-up, there were no neurological events (embolism or stroke) or delayed occurrence of CT in any patient.

Limitations: This preliminary study has several limitations. An important limitation is that this was an observational study with a small sample size. The study was not originally designed to prospectively evaluate the clinical practice of the anticoagulation therapy in relation to CT complicating RFCA of AF after pericardial drainage. Future randomized multicentre studies would strengthen the validity of the results of the present study. In addition, the patients who required surgical intervention were excluded because the anticoagulation strategies could be different from those undergoing pericardial drainage alone.

Conclusion: For patients with CT complicating RFCA of AF, after percutaneous drainage and neutralization of antithrombotic treatment, it is effective and safe to resume the anticoagulation therapy 12 hours after removal of the drainage catheter. This may help to prevent thromboembolic events following RFCA of AF.

ACKNOWLEDGMENTS

We appreciate the efforts of Dr. Mohamed Salim for his contribution during the preparation of this article.

DISCLOSURE

Conflict of interest: None

REFERENCES

1. Calkins H, Kuck KH, Cappato R, *et al.* 2012 HRS/EHRA/ECAS expert consensus statement on catheter and surgical ablation of atrial fibrillation: recommendations for patient selection, procedural techniques, patient management and follow-up, definitions, endpoints, and research trial design. *J Interv Card Electrophysiol* 2012; 33: 171-257. (Review)
2. Hsu LF, Jais P, Hocini M, *et al.* Incidence and prevention of cardiac tamponade complicating ablation for atrial fibrillation. *Pacing Clin Electrophysiol* 2005; 28: S106-9.
3. Hsu LF, Scavée C, Jais P, Hocini M, Haïssaguerre M. Transcatheter pericardiocentesis: an emergency life-saving technique for cardiac tamponade. *J Cardiovasc Electrophysiol* 2013; 14: 1001-3.
4. Themistoclakis S, China P. Whether and when oral anticoagulation therapy should be discontinued after successful ablation of atrial fibrillation. And what about the risk of bleeding? The reasons for not discontinuing oral anticoagulant therapy. *G Ital Cardiol (Roma)* 2013; 14: 272-6. (Italian)
5. Bertaglia E, Zoppo F, Tondo C, *et al.* Early complications of pulmonary vein catheter ablation for atrial fibrillation: a multicenter prospective registry on procedural safety. *Heart Rhythm* 2007; 4: 1265-71.
6. Haïssaguerre M, Hocini M, Sanders P, *et al.* Catheter ablation of long-lasting persistent atrial fibrillation: Clinical outcome and mechanisms of subsequent arrhythmias. *J Cardiovasc Electrophysiol* 2005; 16: 1138-47.
7. Sang C, Jiang C, Dong J, *et al.* A new method to evaluate linear block at the left atrial roof: is it reliable without pacing? *J Cardiovasc Electrophysiol* 2010; 21: 741-6.
8. Bunch TJ, Asirvatham SJ, Friedman PA, *et al.* Outcomes after cardiac perforation during radiofrequency ablation of the atrium. *J Cardiovasc Electrophysiol* 2005; 16: 1172-9.
9. Hoyt H, Bhonsale A, Chilukuri K, *et al.* Complications arising from catheter ablation of atrial fibrillation: temporal trends and predictors. *Heart Rhythm* 2011; 8: 1869-74.
10. Lip GY, Andreotti F, Fauchier L, *et al.* Bleeding risk assessment and management in atrial fibrillation patients: a position document from the European Heart Rhythm Association, endorsed by the European Society of Cardiology Working Group on Thrombosis. *Europace* 2011; 13: 723-46.
11. Scherr D, Sharma K, Dalal D, *et al.* Incidence and predictors of periprocedural cerebrovascular accident in patients undergoing catheter ablation of atrial fibrillation. *J Cardiovasc Electrophysiol* 2009; 20: 1357-63.
12. O'Neill MD, Jais P, Derval N, Hocini M, Haïssaguerre M. Two techniques to avoid surgery for cardiac tamponade occurring during catheter ablation of atrial fibrillation. *J Cardiovasc Electrophysiol* 2008; 19: 323-5.
13. Chilukuri K, Henrikson CA, Dalal D, *et al.* Incidence and outcomes of protamine reactions in patients undergoing catheter ablation of atrial fibrillation. *J Interv Card Electrophysiol* 2009; 25: 175-81.
14. Latchamsetty R, Gautam S, Bhakta D, *et al.* Management and outcomes of cardiac tamponade during atrial fibrillation ablation in the presence of therapeutic anticoagulation with warfarin. *Heart Rhythm* 2011; 8: 805-8.
15. Shah N, Sarode R. Warfarin reversal: schism between clinical practice and published guidelines. *Transfusion* 2013; 53: 476-9.
16. Hirsh J, Dalen J, Anderson DR, *et al.* Oral anticoagulants: mechanism of action, clinical effectiveness, and optimal therapeutic range. *Chest* 2001; 119: 8S-21S. (Review)
17. Hanslik T, Prinseau J. The use of vitamin K in patients on anticoagulation therapy: a practical guide. *Am J Cardiovasc Drugs* 2004; 4: 43-5. (Review)
18. Willms L, Vercaigne LM. Does warfarin safely prevent clotting of hemodialysis catheters? a review of efficacy and safety. *Semin Dial* 2008; 21: 71-7. (Review)
19. Warkentin TE, Crowther MA. Reversing anticoagulants both old and new. *Can J Anaesth* 2002; 49: S11-25. (Review)
20. Mannucci C, Douketis JD. The management of patients who require temporary reversal of vitamin K antagonists for surgery: a practical guide for clinicians. *Intern Emerg Med* 2006; 1: 96-104. (Review)
21. Imamura K, Yoshida A, Takei A, *et al.* Dabigatran in the periprocedural period for radiofrequency ablation of atrial fibrillation: efficacy, safety, and impact on duration of hospital stay. *J Interv Card Electrophysiol* 2013; 37: 223-31.
22. Chang DN, Dager WE, Chin AI. Removal of dabigatran by hemodialysis. *Am J Kidney Dis* 2013; 61: 487-9.
23. Kaireviciute D, Lip GY, Balakrishnan B, *et al.* Intracardiac expression of markers of endothelial damage/dysfunction, inflammation, thrombosis, and tissue remodeling, and the development of post-operative atrial fibrillation. *J Thromb Haemost* 2011; 9: 2345-52.
24. Sparks PB, Jayaprakash S, Vohra JK, *et al.* Left atrial "stunning" following radiofrequency catheter ablation of chronic atrial flutter. *J Am Coll Cardiol* 1998; 32: 468-75.
25. Pisters R, Lip GY. Periprocedural antithrombotic management of patients undergoing ablation for atrial fibrillation: what we currently do and what should we do? *Can J Cardiol* 2013; 29: 139-41.
26. Hamm CW, Bassand JP, Agewall S, *et al.* ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: The Task Force for the management of acute coronary syndromes (ACS) in patients presenting without persistent ST-segment elevation of the European Society of Cardiology (ESC). *Eur Heart J* 2011; 32: 2999-3054.
27. Wazni OM, Beheiry S, Fahmy T, *et al.* Atrial fibrillation ablation in patients with therapeutic international normalized ratio: comparison of strategies of anticoagulation management in the periprocedural period. *Circulation* 2007; 116: 2531-4.
28. Vazquez SR, Johnson SA, Rondina MT. Peri-procedural anticoagulation in patients undergoing ablation for atrial fibrillation. *Thrombosis Research* 2010; 126: e69-77. (Review)
29. Shah A, van den Brink A, de Mol B. Raised international normalized ratio: an early warning for a late cardiac tamponade? *Ann*

- Thorac Surg 2006; 82: 1090-1.
30. Saad EB, d'Avila A, Costa IP, *et al.* Very low risk of thromboembolic events in patients undergoing successful catheter ablation of atrial fibrillation with a CHADS₂ score ≤ 3 : a long-term outcome study. *Circulation Arrhythm Electrophysiol* 2011; 4: 615-21.
 31. Okumura Y. Which is the optimal therapy to prevent thromboembolism after atrial fibrillation ablation procedures in low stroke risk patients, anticoagulation or antiplatelet therapy? *J Cardiovasc Electrophysiol* 2009; 20: 994-6.
 32. Hayashi T, Kumagai K, Naito S, *et al.* Preprocedural therapeutic international normalized ratio influence on bleeding complications in atrial fibrillation ablation with continued anticoagulation with warfarin. *Circulation* 2013; 77: 338-44.