Radiofrequency Catheter Ablation of Ventricular Tachycardia from Right Ventricular Outflow Tract

RUNGROJ KRITTAYAPHONG, MD*,
CHATKANOK DHUMVIBHAT, MD**,
SANSERN CHARERNTHAI, BSc**,
CHARN SRIRATANASATHAVORN, MD**,
THITIMA NUTAKUL, MD***,
CHARUWAN KANGKAGATE, MSc**

Abstract

From January 1996 to May 2002, 61 patients with ventricular tachycardia from right ventricular outflow tract were referred to Siriraj hospital. All patients underwent clinical examination, Doppler echocardiography and electrophysiologic study. Mapping of ventricular tachycardia was performed by activation mapping and pacemapping. There were 44 females and 17 males with an average age of 41.7 ± 9.9 years. Presenting symptoms were palpitation (95.1%), presyncope (39.3%), and syncope (26.2%). Six patients were found to have underlying cardiac disease. Radiofrequency catheter ablation was successful in 56 patients (91.8%). There were no major complications. Seven patients (12.5%) had recurrent ventricular tachycardia. Five of them were successfully reablated. The authors concluded that radiofrequency ablation is an effective treatment in patients with ventricular tachycardia from right ventricular outflow tract.

Key word : Radiofrequency Ablation, Ventricular Tachycardia

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Ventricular tachycardia (VT) is a serious form of cardiac arrhythmia. It usually occurs in patients with structural heart disease such as coronary artery disease, myocardial disease or valvular heart disease (1). However, VT can be found in patients without structural heart disease. The most common form of VT in patients without structural heart disease originates from right ventricular outflow tract (RVOT)(2).

* Division of Cardiology, Department of Medicine,
** Her Majesty Cardiac Center,
*** Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

Patients with VT without structural heart disease usually have a better prognosis when compared to those with structural heart disease[3,4]. Patients can present with palpitation with preserved blood pressure or syncope if hemodynamic compromise which is usually related to the rate of VT. Treatment options include antiarrhythmic medications or radiofrequency catheter ablation (RFCA)[2,5-8]. Medications have limited efficacy and are associated with a certain degree of adverse effects including proarrhythmic effect which may result in more serious ventricular arrhythmia or even increased mortality[9]. There is no recommendation of how long medications should be given. There have been many reports of the use of RFCA in the treatment of this group of patients with excellent efficacy, a slight chance of recurrence and very few complications[2,6-8].

The objective of this study was to describe the outcome of RFCA in the treatment of VT with RVOT morphology in Siriraj Hospital.

METHOD

Study population

From January 1996 to May 2002, there were 61 patients who presented with VT of left bundle branch block and inferior axis morphology (Fig. 1) referred for electrophysiologic study and RFCA at Siriraj hospital. Written informed consent was signed by all patients prior to the procedure. The authors excluded patients who had VT with other morphologies.

Study procedure

All patients had echocardiogram performed before the day of electrophysiologic study to assess the possibility of structural heart disease. Exercise stress test and coronary angiography were performed in selected patients based on their clinical data and physicians.

Demographic data and clinical data were recorded. Clinical presentation, onset and frequency of symptoms, precipitating factors and underlying disease were recorded. Antiarrhythmic medication was discontinued at least 5 half-lives before the procedure.

Electrophysiologic study was performed in the fasting state under light sedation. Surface ECG leads I, aVF, V1 and V6 and intracardiac electrograms were simultaneously displayed and recorded on a multichannel oscilloscopic recorder (Prucka Engineering, Sugar Land, Texas, USA). In patients with spontaneous ventricular arrhythmia, 12-lead ECG morphology of ventricular arrhythmia was saved and printed for the documentation of clinical arrhythmia and for the comparison during mapping (pacemapping). A local anesthetic agent was applied at the right groin. Puncture of the femoral vein was performed with Seldinger's technique. Six-French and 8-French sheath were then inserted into the right femoral vein. Six-French quadripolar Mansfield catheter and 7-French Webster medium curve catheter (Diamond Bar, California, USA) were passed through the right femoral vein into the right ventricular apex and right ventri-

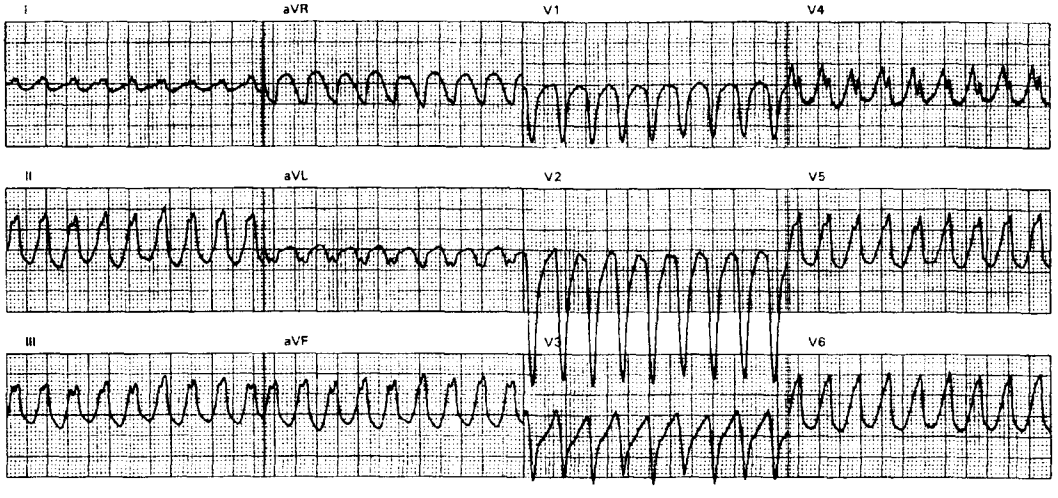

Fig. 1. 12-lead ECG of ventricular tachycardia from right ventricular outflow tract.

cular outflow tract under fluoroscopic guidance (Fig. 2). In patients without spontaneous arrhythmia only the Mansfield catheter was passed to the right ventricular apex for the induction of ventricular arrhythmia. Induction of ventricular arrhythmia was performed by rapid ventricular pacing and programmed electrical stimulation up to triple extrastimulation at 3 running cycle lengths of 400, 500, and 600 msec. Isoproterenol 1 to 5 microgram per minute was infused if ventricular arrhythmia could not be induced and the induction protocol was repeated.

Mapping was performed around the RVOT. Mapping for the target site of ablation was based on 2 techniques: activation mapping and pacemapping. Activation mapping was to search for the site with the earliest local electrical signal. The target site usually has a local electrical signal at least 30 msec earlier than the onset of the ectopic QRS complex (Fig. 3). Pacemapping was performed by the comparison of 12-lead QRS morphology during pacing and during clinical arrhythmia. The target site of ablation should have at least 11 of 12 leads matched with the morphology during clinical arrhythmia (Fig. 4). Radiofrequency power was applied to the target site using the temperature-guided tip of the ablation catheter trying to maintain the temperature at the tip of the catheter around 50-55 degree celcius during VT or during premature ventricular complex of the same morphology of VT. If no beneficial effect was observed, radiofrequency power was discontinued at 20-30 seconds. If beneficial effect was observed, either suppression of ventricular arrhythmia or initially irritable arrhythmia followed by suppression of arrhythmia, the radiofrequency power was maintained for 60 seconds. Bonus burn was applied at the successful site for another 60 seconds to make sure the target site was completely eliminated. Successful ablation was defined as complete elimination of both spontaneous or inducible ventricular arrhythmias with and without isoproterenol infusion at least 30 minutes after successful ablation. Procedure time, fluoroscopic time and number of radiofrequency attempts and complications were recorded. Patients were observed overnight in hospital and discharged the next day. Patients were followed-up at the outpatient department every 3 months for 1 year after the procedure. Patients were instructed to return to the clinic whenever they had recurrent symptoms to verify whether they had recurrent arrhythmia. Patients with recurrent VT were encouraged to undergo repeated electrophysiologic procedure to attempt RFCA again. Patients who failed the procedure were treated with medication.

Statistical analysis

Continuous data were described as mean ± standard deviation. Categorical data were described as frequencies and percentages. Comparison between patients with and without recurrent VT was made by the Student's *t*-test for unpaired data.

RESULTS

A total of 61 patients consisting of 44 females (72.1%) and 17 males (27.9%) with an average age of 41.7 ± 9.9 years ranged from 23-70 years. Pre-

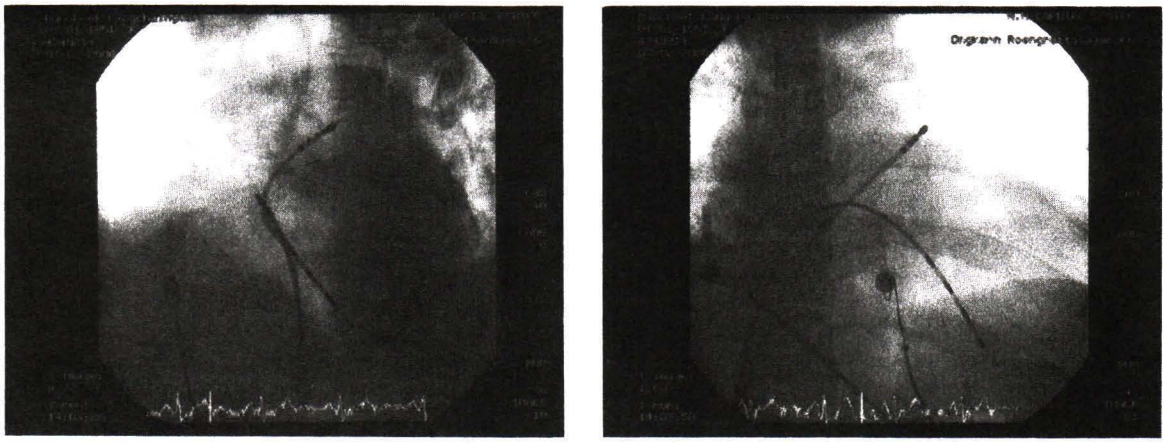

Fig. 2. Left anterior oblique and right anterior oblique cine frame taken after successful ablation procedure in a patient with ventricular tachycardia from the septal side of the right ventricular outflow tract.

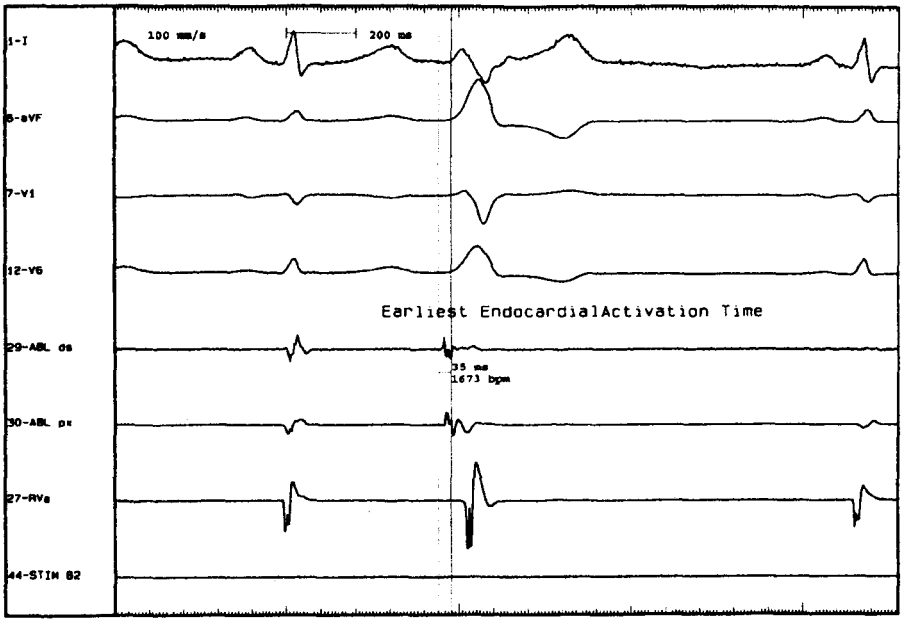

Fig. 3. Local electrogram at the site of successful ablation (ABL-ds) showing 35 msec earlier than the onset of the ectopic QRS complex.

senting symptoms were palpitation in 58 patients (95.1%), presyncope in 24 patients (39.3%) and syncope in 16 patients (26.2%). Average onset of symptoms was 38.4 ± 47.8 months. Six patients (9.8%) had known underlying heart disease or were found to have structural heart disease from echocardiography. Underlying heart disease included atrial septal defect in 2 patients, suspected arrhythmogenic right ventricular dysplasia in 2 patients, one of each had dilated cardiomyopathy and mitral valve prolapse. VT occurred during exertion in 16 patients (26.2%). Exercise test was performed in 14 patients. No patients had ischemic ST changes during exercise. Exercise induced VT occurred in 2 patients. Coronary angiography was performed in 6 patients. All had normal coronary arteries.

Outcomes of RFCA

Sustained VT was demonstrated to have at least 2 morphologies in 10 patients: 6 had 2 morphologies and 4 had 3 morphologies. VT from RVOT was associated with left sided VT in 2 patients: one at the left sided inferoseptal area typical of idiopathic left VT and another at the left ventricular outflow tract. Multiple right sided VT was demonstrated in 8 patients: 6 patients located only on RVOT area and combination of RVOT and RV body in another 2 patients. Single site VT at RVOT was demonstrated in 51 patients.

RFCA could not be performed in 1 patient due to multiple rapid rate VT. Mapping procedure could not be performed due to hemodynamic instability during VT. This patient was suspected to have right ventricular dysplasia from echocardiography. RFCA was successfully performed for VT from RVOT in 56 patients (91.8%). The procedure was failed in 4 patients (6.6%). One of the failed case was a suspected case of right ventricular dysplasia and had multiple site VT. Patients with multiple site VT were successfully ablated in all but 2 cases with suspected right ventricular dysplasia: no radiofrequency attempt in one and failure in another. The other 4 patients with structural heart disease had a successful procedure.

Among 56 patients with successful ablation, the successful site was at the septal side of RVOT in 46 patients (82.1%), free wall of RVOT in 9 patients (16.1%), and intermediate area in 1 patient (1.8%). Local electrical signal at the successful site was 36.4 ± 8.2 msec earlier than the onset of the ectopic QRS

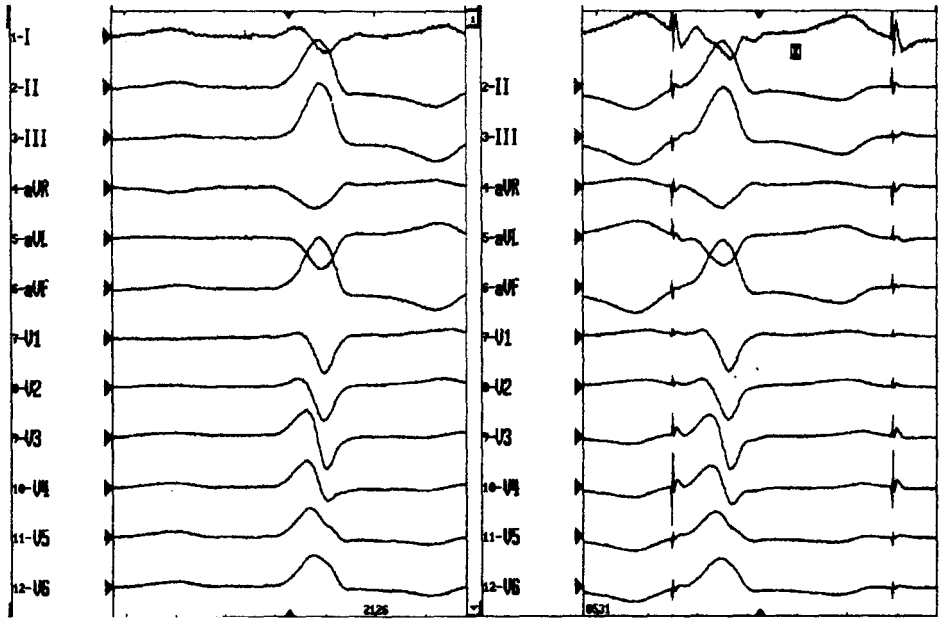

Fig. 4. Pacemapping at the site of successful ablation showing 12/12 matching at the site of successful ablation compared to 12-lead ECG of the ectopic focus.

complex. Pacemapping was 12/12 matched in 47 patients (83.9%) and 11/12 matched in 9 patients (16.1%). The average number of radiofrequency attempts was 7.9 ± 7.5 burns with the average power of 24.6 ± 9.3 watts. Average procedure time was 132.3 ± 73.4 minutes and average fluoroscopic time was 28.5 ± 23.2 minutes. There were 2 minor complications: 1 groin hematoma at the venous puncture site and 1 right bundle branch block from accidental trauma to the right bundle branch.

Seven patients (12.5%) had recurrent VT. Average time of recurrence was 13.3 ± 10.9 months (range 1-30 months). There was no significant difference between patients with and without recurrent VT in age, gender, structural heart disease, or multiple site VT. Five patients with recurrent VT were successfully reablated without recurrence. The other two patients with recurrent VT had multiple VT morphologies on repeated electrophysiologic study and were not considered to be good candidates for treatment with RFCA. Both patients were given antiarrhythmic medication.

DISCUSSION

RFCA has been reported to be an effective treatment in many forms of cardiac arrhythmia. It plays a major role for the treatment of supraventricular tachycardia such as atriovantricular nodal reentry or atrioventricular reciprocating tachycardia using accessory pathway[10]. It has also been reported to be a good treatment option in patients with VT especially in patients without structural heart disease or idiopathic VT[2,6-8]. Idiopathic VT could be right sided or left sided[6,11]. VT with left bundle branch block and inferior axis morphology originates from RVOT and is usually found in patients without structural heart disease[2]. In the present study organic heart disease was demonstrated in 9.8 per cent of patients mainly by echocardiogram and clinical examination. Some studies have demonstrated that if further investigations such as cardiac magnetic resonance imaging more abnormalities will be detected[12,13]. It can occur in healthy young persons with a preferential female gender as seen in the present study. Symptoms during VT vary from asymptomatic or extremely symptomatic such as syncope.

Tsai et al[6] reported that the efficacy of RFCA in the treatment of idiopathic VT was 84 per cent. A similar success rate has also been reported in children and adolescents by Smeets[7] and O'çonner [8]. It was associated with very few complications

(6-8). It is recommended in patients with serious symptoms such as syncope or hemodynamic instability during VT and in those refractory to antiarrhythmic medications. However, patients with non-serious symptoms and good blood pressure during VT should be discussed before choosing either medications or RFCA. In the present study RFCA was successful in 91.8 per cent of the patients. In comparison to previous studies, the present study has the largest number of patients. Only 2 minor complications were encountered. The recurrence rate was 12.5 per cent in the present study despite the complete elimination of ventricular arrhythmia during electrophysiologic study. The recurrence rate was reported to be 19 per cent by Tsai et al(6). Repeated RFCA was successful in 5 out of 7 patients (71.4%) of those who had recurrent VT in the present study.

In conclusion, the authors have demonstrated that RFCA is an effective treatment in patients with VT originating from RVOT. This form of VT can be easily detected from 12-lead ECG morphology during VT. These patients should be examined for underlying organic heart disease. RFCA was associated with very few complications. The recurrence rate was 12.5 per cent. Most patients with recurrent VT can be successfully treated by repeated RFCA.

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REFERENCES

1. Martin D, Wharton JM. Sustained monomorphic ventricular tachycardia. In: Podrid PJ, Kowey PR (eds). Cardiac arrhythmia: Mechanisms, diagnosis and management, 2nd Edition. Philadelphia: Lippincott Wiliams & Wilkins 2001: 573-602.
2. Lerman BB, Stein KM, Markowitz SM, Mittal S, Slotwiner DJ. Ventricular arrhythmia in normal hearts. Cardiol Clin 2000; 18: 265-91.
3. Deal BJ, Miller SM, Scagliotti D, Prechel D, Gallastegui JL, Harison RJ. Ventricular tachycardia in a young population without overt heart disease. Circulation 1986; 73: 1111-8.
4. Lemery R, Brugada P, Della Bella P, Dugernier T, Van den Dool A, Wellens HJJ. Nonischemic ventricular tachycardia: Clinical course and long-term follow-up in patients without clinically overt heart disease. Circulation 1989; 79: 990-9.
5. Iwai S, Lerman BB. Management of ventricular tachycardia in patients with clinically normal hearts. Current Cardiol Reports 2000; 2: 515-21.
6. Tsai CF, Chen SA, Tai CT, et al. Idiopathic monomorphic ventricular tachycardia: Clinical outcome, electrophysiologic characteristics and long-term results of catheter ablation. Intern J Cardiol 1997; 62: 143-50.
7. Smeets JL, Rodriguez LM, Timmermans C, Wellens HJ. Radiofrequency catheter ablation of idiopathic ventricular tachycardia in children. PACE 1997; 20 (8 pt 2): 2068-71.
8. O'Conner BK, Case CL, Sokoloski MC, Blair H, Cooper K, Gillette PC. Radiofrequency catheter ablation of right ventricular outflow tachycardia in children and adolescents. J Am Coll Cardiol 1996; 27: 869-74.
9. Grant AO. Proarrhythmia: Classification, incidence, risk factors, monitoring, prevention, and management. Cardiac Electrophysiol Rev 1998; 2: 127-31.
10. Morady F. Radiofrequency ablation as treatment for cardiac arrhythmia. N Engl J Med 1999; 340: 534-44.
11. Nakagawa H, Beckman KJ, McClelland JH, et al. Radiofrequency catheter ablation of idiopathic left ventricular tachycardia guided by Purkinje potential. Circulation 1993; 88: 2607-17.
12. Globits S, Kreiner G, Frank H, et al. Significance of morphological abnormalities detected by MRI in patients undergoing successful ablation of right ventricular outflow tract. Circulation 1997; 96: 2633-40.
13. Proclemer A, Basadonna PT, Slavish GA, Miani D, Fresno C, Fioretti PM. Cardiac magnetic resonance findings in patients with right ventricular outflow tract premature contractions. Eur Heart J 1997; 18: 2002-10.

ผลการรักษา Ventricular Tachycardia จาก Right Ventricular Outflow Tract ด้วยวิธี Radiofrequency Ablation

รุ่งโรจน์ กฤตยพงษ์, พบ, ชาญ ศรีรัตนสถาวร, พบ**, ฉัตรกนก ทุมวิภาต, พบ**, ฐิติมา นุตกูล, พบ***, สรรเสริญ เจริญไทย, วทบ**, จารุวรรณ คังคะเกตุ, วทม***

คณะผู้วิจัยรายงานการรักษาผู้ป่วยที่ได้รับการวินิจฉัยเป็น ventricular tachycardia (VT) ที่มีจุดกำเนิดจากบริเวณ right ventricular outflow tract (RVOT) ด้วยวิธี radiofrequency catheter ablation จำนวน 61 ราย ผู้ป่วยทุกรายได้รับการซักประวัติ ตรวจร่างกาย ตรวจ echocardiogram ก่อนให้การรักษาโดย RFCA ผู้ป่วย 44 ราย (72.1%) เป็นเพศหญิงอายุเฉลี่ย 41.7 ± 9.9 ปี ผู้ป่วย 95.1% มีอาการใจสั่น, 39.3% มีอาการเกือบเป็นลมหมดสติ, 26.2% มีอาการเป็นลมหมดสติ ผู้ป่วย 6 รายมีโรคหัวใจอย่างอื่นร่วมด้วย ได้หาจุดกำเนิด VT ด้วยวิธี pacemapping และ activation mapping RFCA ประสบความสำเร็จ 56 ราย (91.8%) ไม่มีภาวะแทรกซ้อนชนิดรุนแรง 7 ราย (12.5%) มีการกลับเป็นซ้ำของ VT 5 รายได้รับการทำ RFCA ซ้ำ และประสบความสำเร็จ ดังนั้น RFCA จึงเป็นวิธีรักษาที่ได้ผลดีมากในผู้ป่วย VT จาก RVOT

คำสำคัญ : หัวใจเต้นเร็วจากห้องล่างด้านขวา, การจี้หัวใจด้วยคลื่นไฟฟ้าความถี่สูง

รุ่งโรจน์ กฤตยพงษ์, ชาญ ศรีรัตนสถาวร, ฉัตรกนก ทุมวิภาต, ฐิติมา นุตกูล, สรรเสริญ เจริญไทย, จารุวรรณ คังคะเกตุ
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* ภาควิชาอายุรศาสตร์,
** สำนักงานศูนย์โรคหัวใจสมเด็จพระบรมราชินีนาถ,
*** ภาควิชาวิสัญญีวิทยา, คณะแพทยศาสตร์ศิริราชพยาบาล, มหาวิทยาลัยมหิดล, กรุงเทพ ฯ 10700