Lasso Catheter Guided Ablation for Paroxysmal Atrial Fibrillation : The First Experience in Thailand

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Abstract

The authors used the 10-pole pulmonary vein sized loop-shaped, lasso, catheter *via* a trans-atial septal long sheath in 10 patients who had symptomatic refractory paroxysmal atrial fibrillation (PAF) in order to map and guide for catheter ablation. The radiofrequency current was delivered at the junction between atrial tissue and the pulmonary vein which was the earliest endocardial activation time of the premature atrial contraction (PAC) initiating the PAF and at the pulmonary vein potential during sinus rhythm. Twenty two foci of PAC, 10 and 7, 4 and 1 from left and right superior and left and right inferior pulmonary veins, respectively, and 5 pulmonary vein potentials, 2 and 3 from left and right superior pulmonary veins, respectively, were ablated. After AF ablation, classical atrial flutter (AFl) could be induced in 9 patients. Isthmus line of block for AFl was performed in all patients. Two patients had atrial tachycardia at the high right atrium and also successfully ablated. The mean fluoroscopic and procedure times were 87 and 300 minutes, respectively. One patient had deep vein thrombosis which resolved after anticoagulant therapy. One patient had recurrent PAF which was successfully reablated but he still had very mild symptoms. During the mean follow-up period of 5.8 months, 9 patients remained free of symptoms.

Conclusion : Lasso catheter is an effective tool for mapping and guiding of ablation for PAF. However, more experience and long-term follow-up are required.

Key word : Pulmonary Vein Loop Catheter, Atrial Fibrillation, Ablation

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Atrial fibrillation (AF) is the most frequent supraventricular arrhythmia. The prevalence increases with age and it is a major cause of stroke, especially in the elderly[1]. Most patients experience palpitations, fatigue, dyspnea and dizziness. AF with an uncontrolled ventricular response may develop tachycardia-induced cardiomyopathy[2]. AF can be classified into 3 groups e.g. paroxysmal, persistent and permanent forms. Because of these heterogeneities, there are different methods for ablation such as linear ablation, right atrium alone or both atria ablation, using conventional[3], biosence[4] and noncontact system[5], and the success rate depends on the ablative procedure varying from 60-80 per cent.

After the finding that paroxysmal AF (PAF) can be initiated from ectopic beats, originating in the pulmonary vein (PV) up to 96 per cent and may be cured by ablation[3,6-7]. Focal ablation at the ectopic foci located in PV is being performed more frequently. However, the recurrent and complication rates, especially PV stenosis[6,8], are rather high. It also needs a special high cost machine and catheter for mapping and ablation such as the biosense and non-contact system. These techniques should be restricted for patients with symptomatic AF with refractory to multiple antiarrhythmic agents.

In November 2001, a new multipolar PV sized loop-shaped catheter, lasso catheter, was introduced into Thailand. This catheter was used to record simultaneous circumferential PV activation during premature atrial contraction (PAC) that initiated PAF and pulmonary vein potential (PVP) during sinus rhythm. Ablation could be performed *via* a conventional temperature controlled catheter at the earliest activation of PAC that initiated PAF and eliminated all distal PVP during the sinus rhythm.

The aim of this study was to report the early experience of PAF ablation, using lasso catheter guidance for mapping and ablation in our institute.

PATIENTS AND METHOD

From November 2001 to August 2002, 10 consecutive patients, 4 males and 6 females were referred to our center for AF ablation. All of them had symptomatic refractory PAF, documented by Holter monitoring. The characteristics of the study patients are shown in Table 1. The mean age and duration of symptoms were 56.5 ± 8.9 and 5.6 ± 6.1 years, range 47-70 and 1-20 years, respectively. All patients had failed antiarrhythmic agents class IC (propafenone) and III (amiodarone). Holter monitoring revealed PAF in all cases, range from 10-80 per cent of total heart beats.

After obtaining informed written consent from all patients, an invasive electrophysiological method was performed in the fasting state and after transesophogeal echocardiography revealing no clot in the left atrium (LA) in the morning of the procedure ablation day.

Electrophysiological mapping and ablation

After local anesthesia at both groins and light sedation with intravenous midazolam and propofal infusion, 2 transatrial septal punctures were performed, using a Brockenbrough needle and under fluoroscopic guidance. Two long sheaths, 7F SL 1, USCI, were placed in the LA *via* both transseptal punctures. A 5F pigtail catheter was passed into the

Table 1. Characteristics and results of the study patients.

No	Age (yrs)	Sex	Duration of symptoms (yrs)	Initiation of PAF	Inducible arrhythmia	Ablation	Follow-up (months)
1	61	M	10	S	PAF + AFl	2 PV, AFl	Recur
2	51	F	3	S	PAF + AFl	2PV, AFl	9
3	47	F	2	S	PAF + AFl	1 PV, AFl	9
4	50	F	10	P + I	PAF + AFl	2 PV, AFl	9
5	66	M	1	S	PAF + AFl	2 PV, AFl	8
6	59	M	5	S	PAF + AFl + AT	2 PV, Afl, AT	7
7	47	F	20	P	PAF + AFl	3 PV, AFl	6
8	70	F	1	P + I	PAF + AFl	3 PV, AFl	5
9	48	M	2	S	PAF + AFl + AT	2 PV, AFl, AT	5
10	66	F	2	Non	Non	2 PV, AFl	3

S = spontaneous, P = programmed stimulation, I = isoproterenol infusion, Non = noninducible, PAF = paroxysmal atrial fibrillation, AFl = atrial flutter, AT = atrial tachycardia, PV = pulmonary vein.

body of LA *via* one of the SL1. Left atrial angiography was done during asystole after 12 mg of adenosine rapidly intravenous injection in order to identify the site and size of all PV (Fig 1).

After measuring the size of all PV and choosing the lasso catheter, a conventional ablation and lasso catheters were placed into and at the opening of the right superior pulmonary vein (RSPV) and left superior pulmonary vein (LSPV) respectively. Two 6F quadripolar catheters were also placed at the high right atrium and right ventricular apex. An octapolar catheter was introduced into the coronary sinus. Surface electrocardiography (ECG) lead I, aVL, V1 and V_6 and all intracardiac elecrograms were simultaneously displayed and recorded on a multichannel oscilloscopic recorder, ART and EP Inc.

Mapping of the PV was based on their arrhythmias as described elsewhere[9]. Briefly, all PV were mapped to detect early activation with respect to the surface ECG P wave or the high right atrium reference of the PAC (Fig 2) that initiated PAF. Documentation of active and passive activation of the same PV during different arrhythmia initiations indicated the presence of additional foci. Activation preceding the onset of the surface P wave at different sites also suggested multiple concomitant foci. If there was no spontaneous ectopy during mapping, provocative maneuvers, using isoproterenol infusion and/or programmed stimulation, were used in order to produce a PAC induced PAF and identify the arrhythmogenic PV. If AF was sustained, electrocardioversion was done to convert AF to sinus rhythm and an attempt to map the first PAC that initiated PAF. In patients who had no arrhythmias during the study, the pulmonary vein potential, PVP, defined as a sharp terminal spike on the bipolar electrogram (Fig 3), was used to identify the arrhythmogenic PV. All ectopies and PVP from all PV were ablated at the junction between the atrial tissue and PV using RF power 30 watts and temperature control about 50°C (Fig 4). The end point of the ablation was total abolition of PVP (Fig 5). The initial success criteria was non inducible PAF by programmed stimulation with and without isoproterenol infusion for 30 minutes after the last radiofrequency power on.

Any inducible arrhythmia, rather than PAF, was also ablated in the same procedure. Heparin was given to all patients after successful transeptal puncture. The initial dosage was 2,500 units intravenous injection and followed by 1,000 units intravenous infusion hourly. Activated clotting time (ACT) was measured every 20 minutes. Additional heparin was given to maintain ACT > 250 seconds.

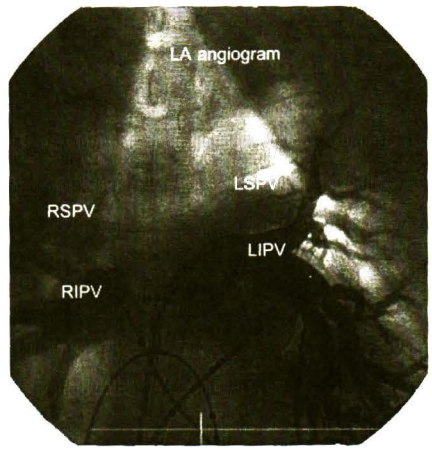

Fig. 1. All pulmonary vein sites and sizes were obtained during left atrial angiography.

Follow-up

After successful ablation, all patients were monitored continuously in the cardiac care unit overnight. All sheaths were taken off and hemostasis was obtained in the cardiac care unit when the monitoring ACT was less than 150 seconds. Anticoagulant and amiodarone 600 mg/day were prescribed to all patients for at least 3 months. All patients were discharged in the next few days if there was no complication.

All patients were followed-up on the regular basis every two weeks in the first few months and every 2-3 months after that. Any symptoms suggestive of PAF were considered evidence of procedural failure, even in the absence of ECG documentation. Holter monitoring was hooked up in all patients after 1-2 months.

RESULTS

Nine patients had PAC induced PAF, 6 spontaneous, 2 by programmed stimulation with isoproterenol infusion and 1 by programmed stimulation without isoproterenol infusion. One patient, no 10, had PAF, documented by Holter monitoring. This patient could not induce any arrhythmia. Twenty four PAC initiated PAF, 10 and 8 foci from left and right superior

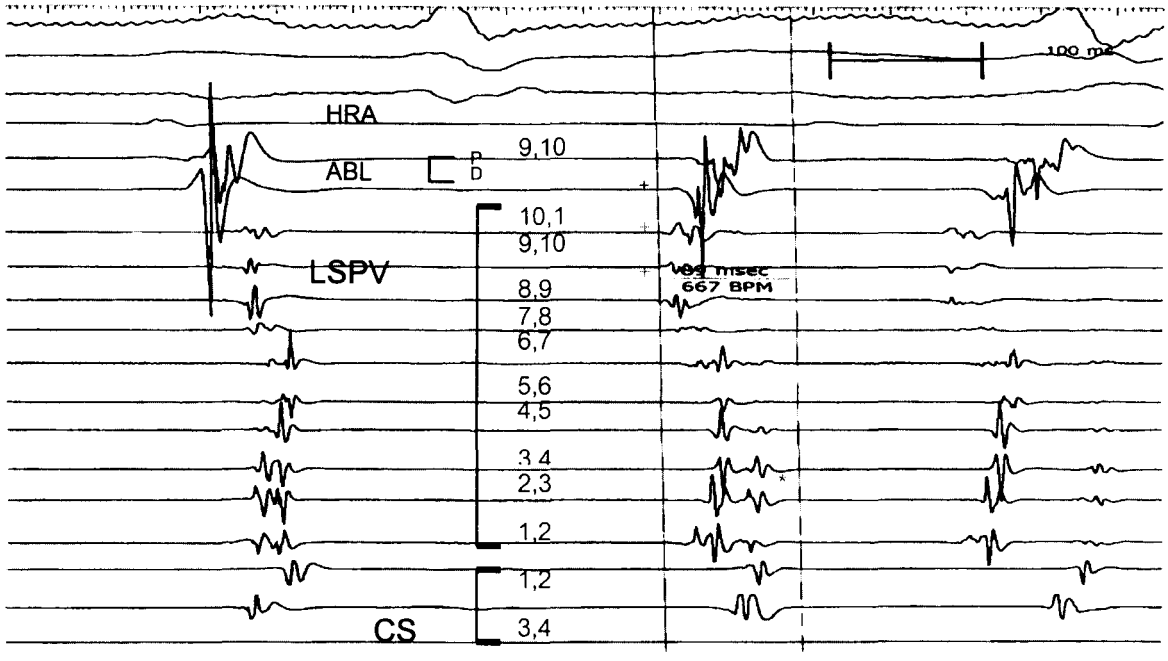

Fig. 2. The early endocardial activation time of the premature atrial contraction initiation paroxysmal atrial fibrillation were detected from the electrode 8-10 (+) of the lasso catheter which located at the os of the left superior pulmonary vein. The other early endocardial activation time was also detected at the electrode 1 (*) which had exist blocked at electrode 6.

PV and 5 and 1 foci from left and right inferior PV, respectively. All were ablated successfully. Five PVP were also ablated during sinus rhythm, 2 each from left and right superior PV and 1 from right inferior PV. The mean number of ablated PV was 2.1 vessels, range 1-3. Patient no 10 who could not induce PAF had PVP in left and right superior PV. All foci of PVP were also abolished.

After segmental PV isolation was done, patients, except patient no 10, had typical atrial flutter (AFl) which was induced by programmed atrial stimulation with and without isoproterenol infusion. Isthmus line of block from tricuspid annulus to inferior vena cava was done in all cases, including patient no 10. After complete isthmus line, supraventricular tachycardia, one scar atrial tachycardia, originating from high right atrium and one atrial tachycardia between high right atrium and superior vena cava, patients no 6 and 9 respectively, were induced by programmed stimulation with isoproterenol infusion. These two tachyarrhythmias were also successfully ablated. The mean fluoroscopic and procedure times were 87 and 300 minutes respectively.

Follow-up

There was no immediate major complication. Patient no 2 had deep vein thrombosis next two days after the procedure which was resolved after anticoagulant therapy. She was discharged 2 weeks after the ablation. Patients no 1 had recurrence 2 hours after ablation. Reablation was done in the next 4 weeks and amiodarone was continued for 6 months rather than 3 months. During the mean follow-up of 6.1 $\pm$ 2.9 months, all patients, except patient no 1, were free of symptoms. Holter monitor in patients who did not refuse monitoring revealed normal monitor or occasional PAC. Patient no 1 still had very mild symptoms after the second procedure of ablation. Before ablation, he had many episodes everyday. The longest episode lasted 3-4 hours. The Holter monitor

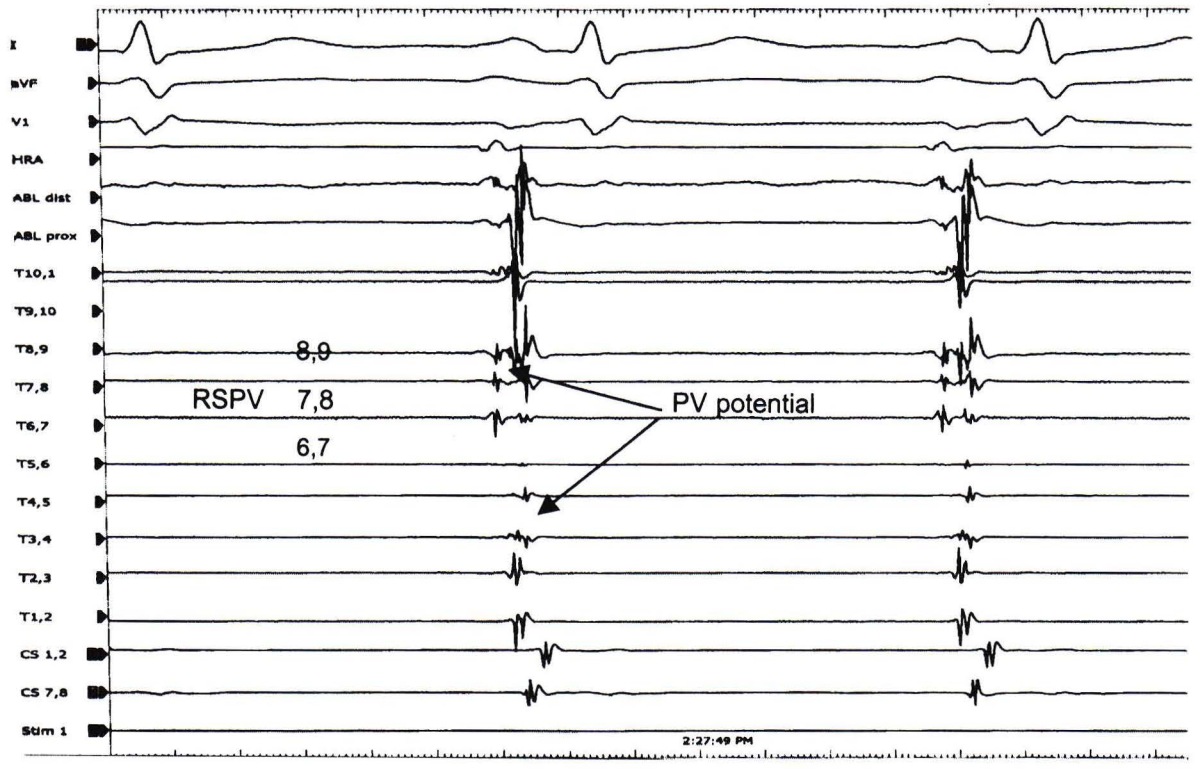

Fig. 3. The pulmonary vein potential, a sharp terminal spike, was detected from the electrode 6-7-8 and 3-4 of the lasso catheter located at the os of right superior pulmonary vein during sinus rhythm.

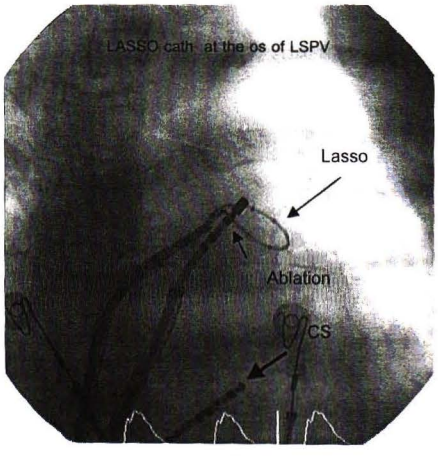

Fig. 4. The relation between lasso and ablation catheters was easily seen during fluoroscopy and the exact site of ablation was determined by the artifact that occurred between these two catheters during radiofrequency power on.

before ablation revealed PAF 80 per cent of total heart beats. He refused monitoring after the second ablation. Amiodarone was discontinued after 6 months follow-up. He still has some palpitation. Nine patients were free of symptoms so the final early success rate was 90 per cent.

DISCUSSION

Main finding

The present study is the first to report the results of PAF ablation, using the lasso catheter for mapping. The overall early success rate in the present study was 90 per cent. Although the follow-up is limited and some recurrence could have been undetected or unrecognized by the patients and/or Holter monitoring. However, all patients in the study were highly symptomatic and failed antiarrhythmic agents class 1c and class III. After ablation it was not difficult to assume that the arrhythmia was either

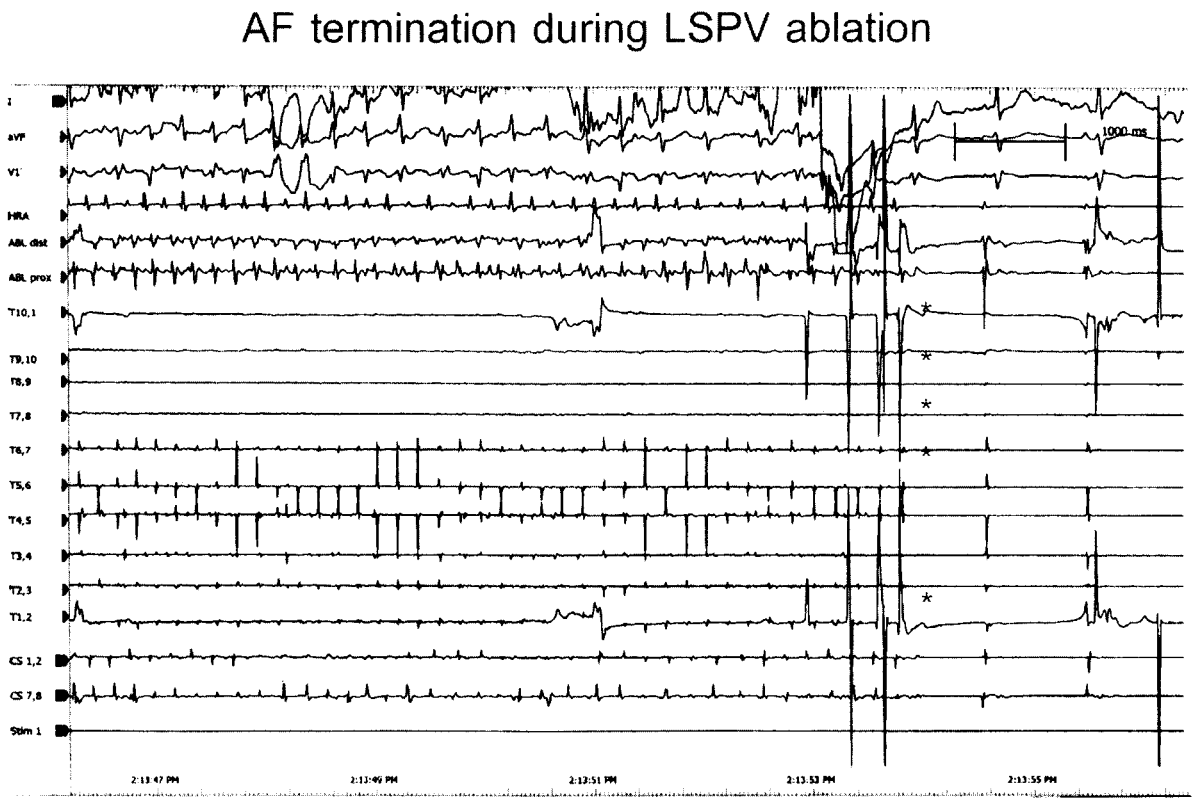

Fig. 5. **Atrial fibrillation in the same patients of Fig. 2. was terminated during radiofrequency current delivery at the electrode 1. Please notify the artifact occurring at electrode 10-1 and 1-2 during ablation and total obolition of the pulmonary vein potential of the electrode 7-10.**

Table 2. **Characteristics of initiating paroxysmal atrial fibrillation and frequency of arrhythmogenic pulmonary veins.**

Initiation	LSPV	RSPV	LIPV	RIPV	Total	%
PAC	10	8	5	1	24	83
PVP	2	2	-	1	5	17
Total	12	10	5	2	29	
%	41	35	17	7		

PAC = premature atrial contraction, PVP = pulmonary vein potential, L = left, R = right, S = superior, I = inferior, PV = pulmonary vein.

eliminated or significantly reduced. All of them, except patient no 1, were free of symptoms without anti-arrhythmic agents. Patient no 1 still had very mild symptom after discontinuation of amiodarone for 2 months.

Target site for ablation

The authors found that spontaneous or provocative PAC from the PV could initiate PAF (Table 2). Twenty nine (94%) *vs* 2 (6%) foci originated from PV and high atrium, respectively, similar to previous

reports[6,7]. Among the PV group, the authors found that the most common arrhythmogenic PV was left superior PV (41%), followed by right superior, left inferior and right inferior PV, 35, 17 and 7 per cent, respectively. Again, this result was similar to previous reports[9]. The authors ablated all PAC that originated from PV and initiated PAF, including PVP, in order to prevent the recurrence. Using the lasso catheter for mapping, it was easy to find the earliest endocardial activation time of the ectopies and PVP. It also found the exact site of delivery for the RF power and the result after ablation by seeing the artifact that occurred from ablation and lasso catheters and total abolition of PVP after ablation. All the patients, except patient no 10, could induce typical atrial flutter after AF ablation. Classical isthmus line of bidirectional block was performed in all cases, including patient no 10 who could not induce any arrhythmia but she had PVP in right and left superior PV and documented PAF by history, surface ECG and Holter monitoring.

Complications and recurrence

The complication and recurrent rates in this study were 10 per cent each. Patient no 2 had deep vein thrombosis in the injured lower extremity because of too many puncture sites at the same vessel and long time of immobilization. There was no significant clinically pulmonary vein stenosis during the mean follow-up of 6 months. The authors performed only segmental PV isolation and ablated at the junction between LA and PV, not into the PV. Low energy power, was also used not more than 30 watts, and temperature control < 50°C. These might be the reasons for the low complication rate in the present.

In patient no. 1, AF recurred about two hours after ablation. Reablation was done and found that many foci of PAC which originated from all PV could initiate PAF. The authors ablated all PV but the PVP could not be completely eliminated in the right lower PV. However, he responded to amiodarone and his symptoms improved. Amiodarone was discontinued 6 months after ablation. The authors do not know whether his symptoms were related to recurrent AF or not because he refused to be hooked up to the Holter monitor.

Comparison with previous studies

The present study had similar efficacy, complication and recurrent rates as previous reports[6,7,9]. The fluoroscopic and total procedure times in the present study were longer than previous studies,

Table 3. Comparison of the results of paroxysmal atrial fibrillation ablation.

Authors	Method for mapping	No of patient	Foci from PV (%)	Flu time (min)	Procedure time (min)	Free of symptom (%)	Follow-up (m)	Procedure per patients
Jais, 1997	Convent	9	67	23	99	89	10	1.1
Haissaguerre, 1998	Convent	29	94	-	-	62	8	2.9
Chen, 1999	Convent	79	89	42	90	56	6	1.1
Pappone, 1999	Biosense	27	RA/LA linear	107	312	59	10	1.0
Shah, 2000	Convent	200	96	48	278	74	16	2.2
Hindrick, 2001	Noncontact	12	75	32	177	67	8	1.3
Ongkarn, 2002	Lasso	10	94	93	317	90	6	1.1

PV = pulmonary vein, min = minutes, Flu = fluoroscopic, m = months, Convent = conventional mapping, RA = right atrium, LA = left atrium

(Table 3). This might be due to our learning experience and time consumed during mapping and ablation periods included transseptal puncture and the 30 minutes waiting time after successful ablation in the cath laboratory.

SUMMARY

The present study showed that ablation of PAF, using the lasso catheter, is feasible with a high success rate and is safe. However, more experience and long-term follow-up are needed.

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การใช้สายสวนหัวใจรูปบ่วงบาศก์ (Lasso catheter) ช่วยในการจี้หัวใจห้องบนเต้นพริ้วชนิดเป็นชั่วขณะ : ประสบการณ์ครั้งแรกในประเทศไทย

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ผู้รายงานได้นำสายสวนหัวใจรูปบ่วงบาศก์ สำหรับตรวจไฟฟ้าภายในหัวใจชนิด 10 ขั้ว เพื่อวัดไฟฟ้าหัวใจรอบรูเปิดของหลอดเลือดดำจากปอด ผ่านรูเจาะผนังกั้นหัวใจห้องบนเพื่อใช้หาตำแหน่งที่จะจี้หัวใจด้วยคลื่นไฟฟ้าความถี่เท่าคลื่นวิทยุในผู้ป่วย 10 รายที่มีภาวะหัวใจห้องบนเต้น พริ้วชนิดเป็นชั่วขณะ พบว่า 22 จุดของหัวใจห้องบนเต้นเร็วผิดจังหวะ และทำให้เกิดหัวใจเต้นพริ้วอยู่ที่หลอดเลือดดำจากปอด อีก 2 จุด มาจากหัวใจห้องบนขวา ผู้ป่วยได้รับการจี้จุดกำเนิดหัวใจเต้นผิดจังหวะและได้ทำ line of block ระหว่างลิ้นหัวใจไตรคัสปิด และหลอดเลือดดำ inferior vena cava ระยะเวลาผู้ป่วยโดนรังสี และเวลาที่ใช้ทั้งหมดในห้องปฏิบัติการสวนหัวใจคือ 87 และ 300 นาที ตามลำดับ ผู้ป่วยหนึ่งรายเกิดภาวะหลอดเลือดดำที่ขวาตีบตันและดีขึ้นหลังได้ยาละลายลิ่มเลือด ผู้ป่วยหนึ่งรายเกิดเป็นซ้ำต้องได้รับการจี้ครั้งที่ 2 และอาการลดลงมาก ในระยะติดตามอาการ 6 เดือน ผู้ป่วย 9 ราย (90%) ไม่มีอาการ

สรุป : สายสวนหัวใจรูปบ่วงบาศก์ชนิด 10 ขั้ว เป็นอุปกรณ์ที่มีประโยชน์ในการวัดไฟฟ้าหัวใจ และชี้นำในการจี้หัวใจของผู้ป่วยหัวใจห้องบนเต้นพริ้วชนิดเป็นชั่วขณะ อย่างไรก็ตามจำเป็นต้องมีประสบการณ์และผลการติดตามในระยะยาวต่อไป

คำสำคัญ : สายสวนหัวใจรูปบ่วงบาศก์, หัวใจห้องบนเต้นพริ้ว, การจี้หัวใจ

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