Reversibility of Tachycardiomyopathy After Successful Radiofrequency Catheter Ablation : Intermediate Results

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Abstract

Left ventricular function in patients with tachycardia induced cardiomypopathy can improve after cessation of the arrhythmia. We reported the intermediate results of 10 patients, 6 men and 4 women, with tachycardiomyopathy who successfully underwent radiofrequency catheter ablation (RFCA) for incessant tachycardia. Three had right atrial tachycardia, 5 ventricular tachycardia (2 and 3 from the right and left ventricles, respectively), 1 atrial flutter and 1 right accessory pathway. During the mean follow-up period of 19 months (range 11-38 months), one patient, right atrial tachycardia, had recurrence and reablation was successfully done without recurrence.

Left ventricular ejection fraction, endsystolic and diastolic diameters from echocardiography gradually improved from 35 per cent, 51 and 61 mm to 58 per cent, 36 and 52 mm, respectively ($p<0.001$). The mean duration of reversibility was 7 months (range 1-15 months). There was no recurrence of tachycardiomyopathy after the return of left ventricular function. Conclusion, RFCA can terminate tachyarrhythmia and lead to significant improvement of left ventricular diameters and systolic function in patients with tachycardia induced cardiomyopathy.

Key word : Tachycardia, Cardiomyopathy, Ablation

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Chronic uncontrolled tachycardia, both supraventricular and ventricular arrhythmias, may result in left ventricular dysfunction[1-4]. This form of tachycardia induced left ventricular dysfunction is known as tachycardiomyopathy. The clinical setting of the patient who has tachycardiomyopathy is similar to the patient who has dilated cardiomyopathy. Furthermore, these tachyarrhythmias have been observed in patients with dilated cardiomyopathy[5-7]. It is difficult to say whether left ventricular dysfunction is a primary or secondary phenomenon. However, cessation or control of the heart rate results in recovery of heart failure and left ventricular functions, partially or completely, in patients with tachycardia induced cardiomyopathy[2-4].

Radiofrequency catheter ablation (RFCA) has been reported as a useful method to cure certain types of both supraventricular and ventricular tachyarrhythmias[8-16]. In this study, we reported, to our knowledge, the first series of tachycardiomyopathy which reversed left ventricular function after successful RFCA in Thailand.

PATIENTS AND METHOD

The study population consisted of 10 patients who were referred to Her Majesty Cardiac Centre, Siriraj Hospital for electrophysiologic study and management of incessant supraventricular and ventricular tachycardias. All patients had complete history taking, physical examination, baseline electrocardiography, chest roentgenography and echocardiography (Sonos 1000, Hewlett Packard). Coronary angiography was performed in patients aged more than 40 years and revealed normal study in all patients.

Electrophysiologic study and mapping

After informed written consent from all patients, an invasive electrophysiologic study was performed in the fasting state. Quadripolar electrode catheters were placed in the high right atrium, at the apex of the right ventricle and His position. For coronary sinus mapping, an octapolar catheter was inserted into this vessel. The catheters were positioned under fluoroscopic guidance and the exact sites were determined by the intracardiac electrogram recorded. Surface ECG leads I, aVF, V_1 and V_6 and intracardiac electrograms were simultaneously displayed and recorded on a multichannel oscilloscopic recorder (ART and EP Inc). Programmed electrical stimulation, mapping and ablation were performed as previously described from our laboratory [17-19] and elsewhere[8,12,16]. Briefly, for right atrial tachycardia, atrial mapping was performed by using the double ablation catheter technique. One ablation catheter was moved to the region of the earliest potential activation relative to the tachycardia P-wave onset. Then, the second ablation catheter was moved around the first catheter to find an earlier potential activation (encircling technique). For patients with an accessory pathway, atrial and ventricular stimulations were done in order to induce tachycardia to try to find the accessory pathway, using the earliest potential activation. For ventricular tachycardia, programmed stimulation was performed at the right ventricular apex and/or outflow tract with up to 3 extrastimuli and 3 back up pacing cycle lengths. The earliest endocardial activation time and pace mapping were used to identify the site for ablation. For patients with atrial flutter, atrial stimulation was performed in order to induce sustained atrial flutter if atrial flutter spontaneously occurred at the beginning of the study, atrial mapping and ablation were performed before any programmed atrial stimulation.

For patients who needed left side mapping and ablation, an initial bolus of 2,500 units of heparin was administed intravenously before mapping, followed by maintenance doses of 1,000 units hourly until the procedure was completed.

Radiofrequency ablation

After localizing the site for ablation and intravenous infusion of fentanyl and propolfal, radiofrequency current of 20-50 watts was delivered between the distal pole of the ablation catheter and a large surface-area skin patch placed over the felt scapula, for 25-60 seconds or until a sudden increase in impedance indicative of coagulum formation. The catheter was only removed when an abrupt impedance increased or to find a more accurate ablation site. For atrial flutter, ablation was performed, by using anatomical approach, at tricuspid annulus-inferior vena cava or tricuspid annulus-coronary sinus isthmus to create a line of conduction

block at the isthmus. If tachycardia terminated within 15 seconds after the beginning of the radiofreguency application, radiofrequency current was continued to 60 seconds. If ablation was successful, another application was delivered at the same power and duration. Programmed stimulation, both with and without isoproterenol, was repeated immediately and 30 minutes after successful ablation to confirm the absence of inducible tachyarrhythmia before removing all catheters and sheaths.

Follow- up

After the ablation procedure, all patients were monitored continuously in hospital for 24-48 hours. Echocardiography was done on the day after ablation, if possible, or before hospital discharge without an antiarrhythmic agent. Each patient was observed on a regular basis every 2 weeks to 1 month when the left ventricular function and diameters did not return to normal range and 1-3 months after the return of left ventricular function. Electrocardiography and echocardiography were done at each visit.

Statistical analysis

All measured variables were presented as mean ± SD and were compared by using Student's paired *t*-test. The p-value less than 0.05 was considered statistically significant.

RESULTS

The study population consisted of 10 patients, 6 men and 4 women. The clinical characteristics of the patients are shown in Table 1. The mean age was 35.6 ± 18.9 years (range 12-64 years). All had symptomatic incessant tachycardia, 3 each with right atrial and left ventricular tachycardias, 2 right ventricular outflow tract tachycardia and one each with atrial flutter type I and right accessory atrio-ventricular pathway. Seven patients (70%) had clinical congestive heart failure, NYHA functional class III and IV in 6 and 1 patients, respectively. The mean duration of symptoms was 32.1 ± 40.1 months (range 1 month-10 years).

RFCA was successfully done in all patients. Three patients, patient no 3, 8 and 10, had progressive heart failure and respiratory insufficiency. They needed endotracheal intubation and respiratory support during and after

Table 1. Clinical characteristics and echocardiographic findings before and after ablation of the study population.

No	Sex/age	Symptoms	Duration of symptoms	Functional class	Diagnosis	ECHO				Duration of reverse LV function (wks)
						Before		After		
						LV dias/syst diameters (mm)	EF (%)	LV dias/syst diameters (mm)	EF (%)	
1.	M/12	P, CHF	7 Y	III	R. AT	64/56	23	55/36	57	24
2.	M/29	P	1 Y	II	R. AT	62/48	40	49/37	54	32
3.	F/18	P, CHF	6 M	IV	R. AT	58/48	35	48/34	65	24
4.	M/55	P, CHF	3 Y	III	AFl. I	62/56	27	58/45	55	32
5.	M/25	P	2 Y	II	WPW	60/46	47	54/35	64	12
6.	F/26	P	10 Y	II	R. VT	66/53	38	55/40	47	4
7.	F/49	P, CHF	1 M	III	R. VT	68/52	42	43/29	55	24
8.	M/64	P, CHF	1 M	III	L. VT	70/55	38	57/40	51	32
9.	F/58	P, CHF	1 M	III	L. VT	55/43	39	44/27	77	40
10.	M/20	P, CHF	3 Y	III	L. VT	73/60	28	59/39	59	60

LV = left ventricle, EF = ejection fraction, P= palpitation, CHF = congestive heart failure, Y= years, M= months, Wks = weeks, RAT = right atrial tachycardia, AFl I = atrial flutter type I, WPW = Wolff- Parkinson- White, RVT = right ventricular tachycardia, LVT= left ventricular tachycardia, dias/syst = diastolic/systolic

the procedure. All of them were extubated after 1-3 days and discharged within 2 weeks after ablation. Patient no 3 had recurrence of right atrial tachycardial 1 hour after RFCA while in the cardiac care unit. Cardioversion was done which terminated atrial tachycardia to sinus rhythm. She was discharged with amiodarone but she still had atrial tachycardia without clinical heart failure. A second ablation procedure, 3 months after the first ablation, was successfully done at the same area without recurrence.

During the mean follow-up of 19 ± 8.1 months (range 11-38 months), the echocardiographic findings after ablation revealed significant improvement of left ventricular systolic function and diameters (p = 0.000, Table 2). The mean duration of reversibility to normal range was 28.4 ± 15.2 weeks (range 4-60 weeks). There was no recurrence after the reversibility of left ventricular function and diameters.

Table 2. Echocardiographic findings before and after ablation.

	Before	After	P-value
LV diameters			
Systole (mm)	51.7 ± 5.3	36.2 ± 5.3	0.000
Diastole (mm)	63.8 ± 5.5	52.2 ± 5.8	0.000
LV EF (%)	35.7 ± 7.5	58.4 ± 8.5	0.000

LV = left ventricle, LVEF = left ventricular ejection fraction.

DISCUSSION

Chronic incessant tachyarrhythmias have been demonstrated as a cause of significant left ventricular dysfunction and development of congestive heart failure. The severity of this complication is determined by the duration and rate of the arrhythmia. In animal models, significant left ventricular dysfunction was observed after 3 months of supraventricular tachycardia with the rate of 190 beats/min[20]. Cessation or control of the heart rate by cessation of pacing in animal models[20], antiarrhythmic agents[21], surgical[22,23] and catheter ablation [24,25], have been reported to resolve left ventricular dysfunction in such patients.

The mechanisms of tachycardia induced cardiomyopathy are unclear. In animal models, they may be related to depletion of myocardial high energy storage[26,27], myocardial ischemia due to reduction of myocardial blood flow[28] or structural abnormalities[29,30], especially in myofibrillar contractile protein[31]. Cessation of the tachycardia results in repletion of high energy substrates and return of myocardial blood flow and leads to normalization of left ventricular function.

The recovery of ventricular function in animal models has been well reported[20,22, 25,31,32]. Left ventricular ejection fraction significantly recovered in 24 to 48 hours and normalized after 1-2 weeks of termination of rapid pacing[31] but left ventricular dilatation persisted for 3 months after termination of pacing[20,31,32]. In human beings, ejection fraction also recovered as rapidly as in animal models[33]. The increase in ejection fraction was mainly due to a marked decrease in left ventricular end-systolic diameter. A decrease in left ventricular end-diastolic diameter was also noted and gradually improved to normal range varying from 3-12 months[22,25].

In our study, we reported 10 patients who had tachycardia, both supraventricular and ventricular tachycardia induced left ventricular dysfunction. RFCA terminated tachyarrhythmia in all patients. Left ventricular ejection fraction and end systolic diameter improved before diastolic diameter. It occurred in the first two weeks of our 8 patients. Another two patients, patient no 8 and 10, had no improvement in left ventricular function but were free of heart failure. The end diastolic diameter in these two patients increased after ablation but gradually improved after the second week post ablation. Both systolic and diastolic diameters in our study were significantly reversed to normal range which varied from 1 to 15 months after ablation, similar to previous reports[21-25]. The limitations of this study were 1) this report was the intermediate term results because tachyarrhythmia can recur after long term, such as 3 years in our experience, and can induce cardiomyopathy again. 2) Endomyocardial biopsy was not performed in all our patients. The result of biopsy may explain the variation of reversibility of the left ventricular function.

In conclusion, chronic tachycardia may be the primary problem leading to secondary left ventricular dysfunction. Evaluation of all patients with left ventricular dysfunction should include assessment of heart rate and rhythm, because appropriate treatment of tachyarrhythmia can lead to dramatic clinical and left ventricular functional improvement.

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ภาวะหัวใจโตเลือดคั่งกลับเป็นปกติหลังการรักษาด้วยการจี้หัวใจด้วยคลื่นไฟฟ้าความถี่สูงเท่าคลื่นวิทยุ

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คณะผู้รายงานได้ทำการรักษาผู้ป่วยโรคหัวใจโตเลือดคั่ง (dilated cardiomyopathy) ที่เกิดจากหัวใจเต้นเร็วผิดปกติด้วยการจี้หัวใจด้วยคลื่นไฟฟ้าความถี่สูงเท่าคลื่นวิทยุ (radiofrequency catheter ablation, RFCA) จำนวน 10 ราย ชาย 6 ราย หญิง 4 ราย ทุกรายมีภาวะหัวใจเต้นเร็วผิดปกติเกือบตลอดเวลา เป็น atrial tachycardia จากหัวใจห้องบนขวา 3 ราย จากหัวใจห้องล่าง 5 ราย (2 และ 3 รายจากหัวใจห้องล่างขวาและซ้ายตามลำดับ) ทุกรายประสบผลสำเร็จ ในช่วงระยะติดตามเฉลี่ย 19 เดือน ผู้ป่วย 1 ราย (atrial tachycardia) กลับเป็นซ้ำ และประสบผลสำเร็จด้วยการจี้ครั้งที่ 2 โดยไม่กลับเป็นซ้ำอีก ejection fraction ขนาดของหัวใจห้องล่างซ้ายช่วง systole และ diastole จากการตรวจหัวใจด้วยคลื่นเสียงสะท้อนความถี่สูง (echocardiography) ดีขึ้นอย่างมีนัยสำคัญทางสถิติจาก 35%, 51 และ 61 ม.ม. เป็น 58%, 36 และ 52 ม.ม. ตามลำดับ ($p<0.001$) ในระยะเวลาเฉลี่ย 7 เดือน (range 1–15 เดือน) หลังหัวใจกลับเป็นปกติ ไม่มีผู้ป่วยรายใดกลับเป็นโรคหัวใจโตเลือดคั่งอีก

คำสำคัญ : หัวใจเต้นเร็วผิดจังหวะ, หัวใจโตเลือดคั่ง, การจี้หัวใจ

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