Radiofrequency Catheter Ablation of Wolff-Parkinson-White Syndrome: Report of 83 Cases from Siriraj Hospital

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Abstract

We described the characteristics of patients and accessory pathway and showed our results of Radiofrequency catheter ablation (RFCA). There were 41 males and 42 females at a mean age of 36 years. Accessory pathway associated with Wolff-Parkinson-White (WPW) syndrome in our population was more prevalent on the right side which is different from previous reports. Most commonly associated heart disease was Ebstein's anomaly. Overall success rate was 96.4 per cent. Right free wall accessory pathway needed a longer procedure time and fluoroscopy time, higher radiofrequency power and more radiofrequency applications compared to other locations. Although the recurrence rate was 12 per cent, all patients with recurrence were successfully reablated. We also described the comparison of our result with previous studies. To our knowledge this is the first report in Thailand with a reasonable number of cases. RFCA is a very effective treatment of WPW syndrome in the Thai population and should be considered in symptomatic patients especially those who are refractory to medication.

Key word : Radiofrequency Catheter Ablation, WPW Syndrome

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BACKGROUND

The hallmarks of ECG findings in Wolff-Parkinson-White (WPW) syndrome are delta wave, short PR interval and wide QRS complex. Patients with WPW syndrome can have various kinds of cardiac arrhythmia including supraventricular tachycardia (SVT), atrial fibrillation or malignant ventricular arrhythmia[1]. However, many patients with WPW syndrome are asymptomatic. Prognosis in asymptomatic cases is excellent and treatment is usually not indicated[2,3]. Prevalence of WPW syndrome has been estimated to be 0.15-0.25 per cent[4]. Successful catheter ablation of an accessory pathway was reported in 1984 using direct-current (DC) energy[5]. The drawbacks of DC shocks such as a lack of energy titration, risk of barotrauma, and the need for general anesthesia, have led to the adoption of an alternative source of ablation energy namely alternating current in the radiofrequency range (30 kHz to 300 kHz). In 1987 Borggrefe et al[6] reported the first case of radiofrequency catheter ablation (RFCA) of a right sided accessory pathway in a human. Up to now there have been many reports about the treatment of WPW syndrome by RFCA with a high success rate[7-15]. Advantages of this treatment option include a high success rate, less invasion compared to surgical treatment, no need for long term medication and low complication rate. RFCA has also been shown to be cost-effective compared with other treatment strategies in WPW syndrome[16].

From the National ECG survey 1991-1992 in Thailand the prevalence of WPW pattern from ECG criteria was 1.4 per 1000 population[17]. Little is known about WPW syndrome in the Thai population. To our knowledge this is the first publication of the use of RFCA in the treatment of symptomatic patients with WPW syndrome in a Thai population. The aims of this report were to study 1) characteristics of patients and WPW syndrome 2) success rate, complications and recurrent rates of RFCA among a Thai population in Siriraj Hospital.

METHOD

From January 1995 to December 1998 there were 83 patients with WPW syndrome treated by RFCA at Siriraj Hospital. WPW syndrome was diagnosed by standard ECG criteria. All patients were symptomatic and had ECG documentation of SVT. We reviewed the patients' demographic data, clinical presentation, associated heart disease, location and number of bypass tracts, inducible arrhythmia, RFCA result, complication rate, recurrence rate and associated cardiac arrhythmia.

Electrophysiologic study (EPS)

Written informed consent was obtained prior to EPS in all patients. Electrophysiologic study was performed in the fasting state after discontinuation of all antiarrhythmic agents under local anesthesia and light sedation. Two 6 Fr quadripolar electrode catheters were passed from the right femoral vein to a position at the high right atrium and right ventricular apex. One 7 Fr ablation catheter (Webster or EP tech) was passed from the right femoral vein for right sided bypass tract and from the right femoral artery for retrograde approach of left sided bypass tract. The appropriate position for mapping and doing ablation was guided by the surface ECG. For anteroseptal bypass tract one quadripolar mapping catheter was positioned at His bundle area to avoid the risk of injury to His bundle. If detailed mapping of the left sided bypass tract is needed one octapolar or decapolar mapping catheter will be positioned in the coronary sinus. All catheters were positioned under fluoroscopic guidance and the exact sites were determined by the intracardiac electrogram. Surface ECG leads I, aVF, V1, and V6 and intracardiac electrogram at various positions were simultaneously displayed and recorded on the multichannel oscilloscopic recorder (Cardiolab, Pructa Engineering). Baseline 12-lead ECG, PR interval and total QRS duration were recorded. Intravenous heparin was given to all patients with left sided ablation.

Atrial and ventricular stimulations were performed to induce tachyarrhythmia and study antegrade and retrograde conduction of the bypass tract. Characteristics and cycle length of SVT were recorded. In case SVT could not be induced, isoproterenol was given and stimulation protocol was repeated. The diagnostic part of the EPS was aimed at assessing the conduction properties of the bypass tract and induction of the SVT.

Radiofrequency ablation technique

Site of bypass tract was roughly classified by the 12-lead surface ECG into left sided or right sided, free wall or septal area. Mapping of the exact bypass tract location was guided by identifying the site that has earliest ventricular activation during antegrade bypass tract conduction and it was com-

pared to the onset of delta wave. In some cases mapping was performed by identifying the site of earliest atrial activation during retrograde conduction *via* bypass tract during either ventricular pacing or orthodromic reciprocating tachycardia (ORT). We used the retrograde approach for ablation of left sided bypass tract. For ablation of right sided bypass tract the catheter was positioned on the atrial aspect of the tricuspid valve. The following criteria were employed to identify the target site for RFCA 1) discrete atrial and ventricular signal 2) local ventricular electrogram at least 20 msec earlier than the onset of delta wave. Accessory pathway (AP) potential may also help to identify the bypass tract location in some patients (Fig. 1). Both right anterior oblique and left anterior oblique images were used for mapping and identifying the target site for ablation (Fig. 2). Once the bypass tract was located, radiofrequency energy was applied to that location. To attempt successful ablation the temperature at the catheter tip was raised to 50-55 degree Celsius during sinus rhythm. If there was no evidence of ECG change after 10-15 seconds, RF power was then terminated. If the ECG returned to normal (Fig. 3) the RF power was proceeded to 60 seconds and time to ECG change was recorded. Successful RF ablation was defined as complete elimination of antegrade and retrograde bypass tract conduction without inducible SVT with and without isoproterenol for up to 30 minutes after successful ablation. Procedure time, fluoroscopy time and complication of procedure were recorded. We used a long venous sheath to stabilize the ablation catheter in patients with the bypass tract located at the right free wall if the ablation catheter could not be maintained in a good position during ablation.

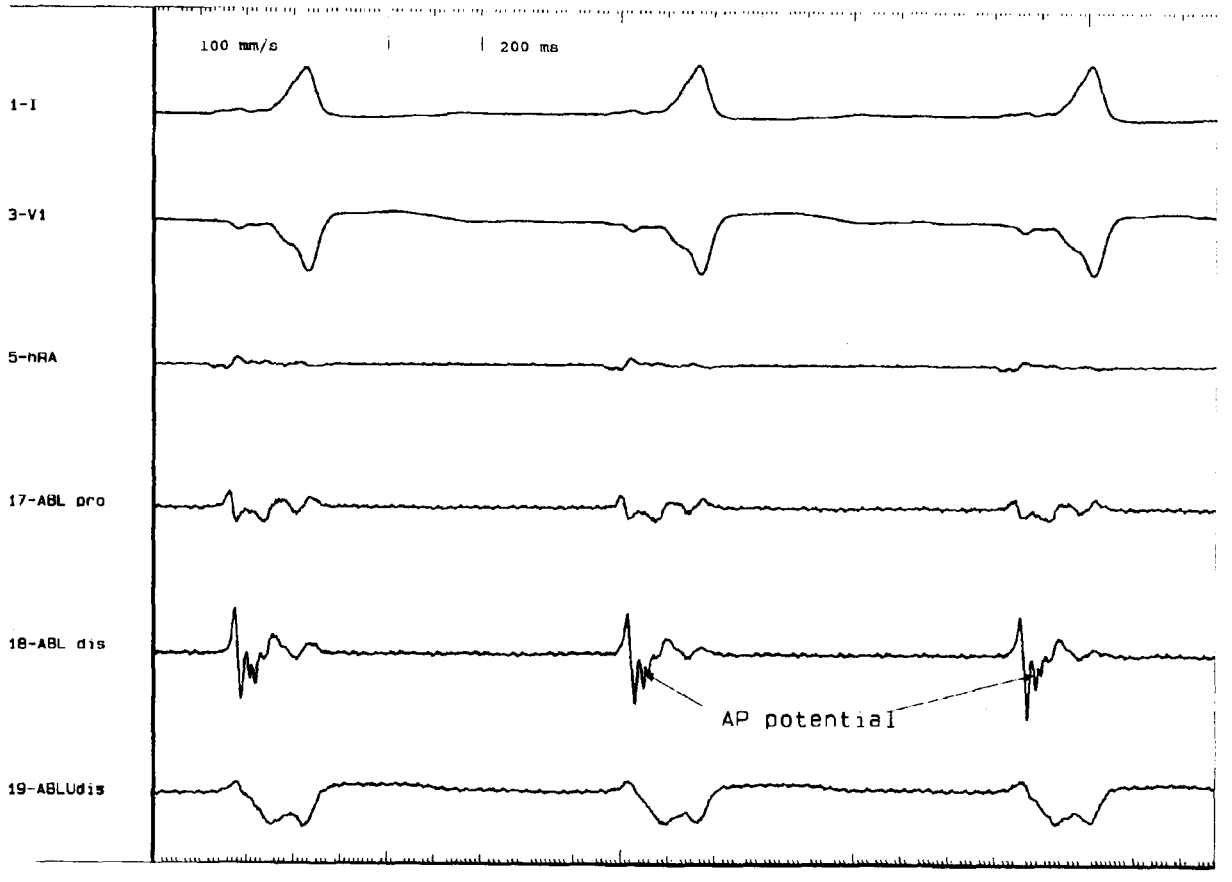

Fig. 1. This patient had a right-sided accessory pathway. Note accessory pathway potential on local electrogram and the earliness of local ventricular electrogram compared to the onset of delta wave (44 msec earlier).

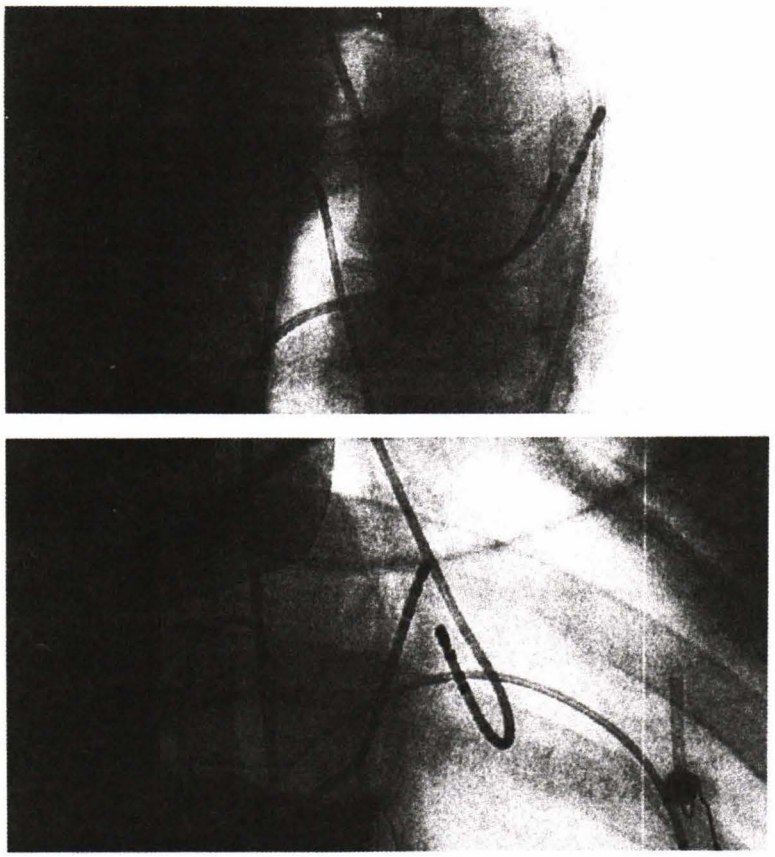

Fig. 2. Left anterior oblique and right anterior oblique cine frame taken during successful ablation procedure in a patient with left free wall accessory pathway. Diagnostic electrode catheters were placed into the high right atrium, right ventricular apex and coronary sinus. Ablation catheter was placed through the femoral artery and positioned in the left ventricle under the mitral valve apparatus at the site of the accessory pathway. This position was determined by initial mapping in the coronary sinus. Application of the radiofrequency energy resulted in successful ablation of the pathway.

Patients were followed-up for at least 3 months. If there was evidence of recurrence of WPW syndrome RFCA was attempted again.

Statistical analysis

Data are presented as mean (±SE) value. Proportion data are presented as count and percentages. In case of a non-Gaussian distribution of measured variables the median value is given instead of using mean and nonparametric test for analysis. Continuous data were compared by an unpaired *t*-test or ANOVA. Categorical variables were compared by Chi-square test. The p-value less than 0.05 were considered significant.

RESULTS

From a total of 83 patients, there were 41 males (49.4%) and 42 females (50.6%) with a mean age of 36±1.7 years (age range from 6 to 74 years). Seven patients (8.4%) were younger than 15 years. Presenting symptoms included: palpitation (94%), presyncope (15.7%), syncope (6%), and chest pain (13.3%). All patients had ECG documented WPW syndrome. 9 patients (10.8%) had intermittent preexitation from surface ECG. Average duration of symptom was 84.6±9.8 months and average frequency of attack was 103±30.8 per year. Thirteen patients (15.7%) had associated heart disease: 6 Ebstein's anomaly, 3 valvular heart disease, one

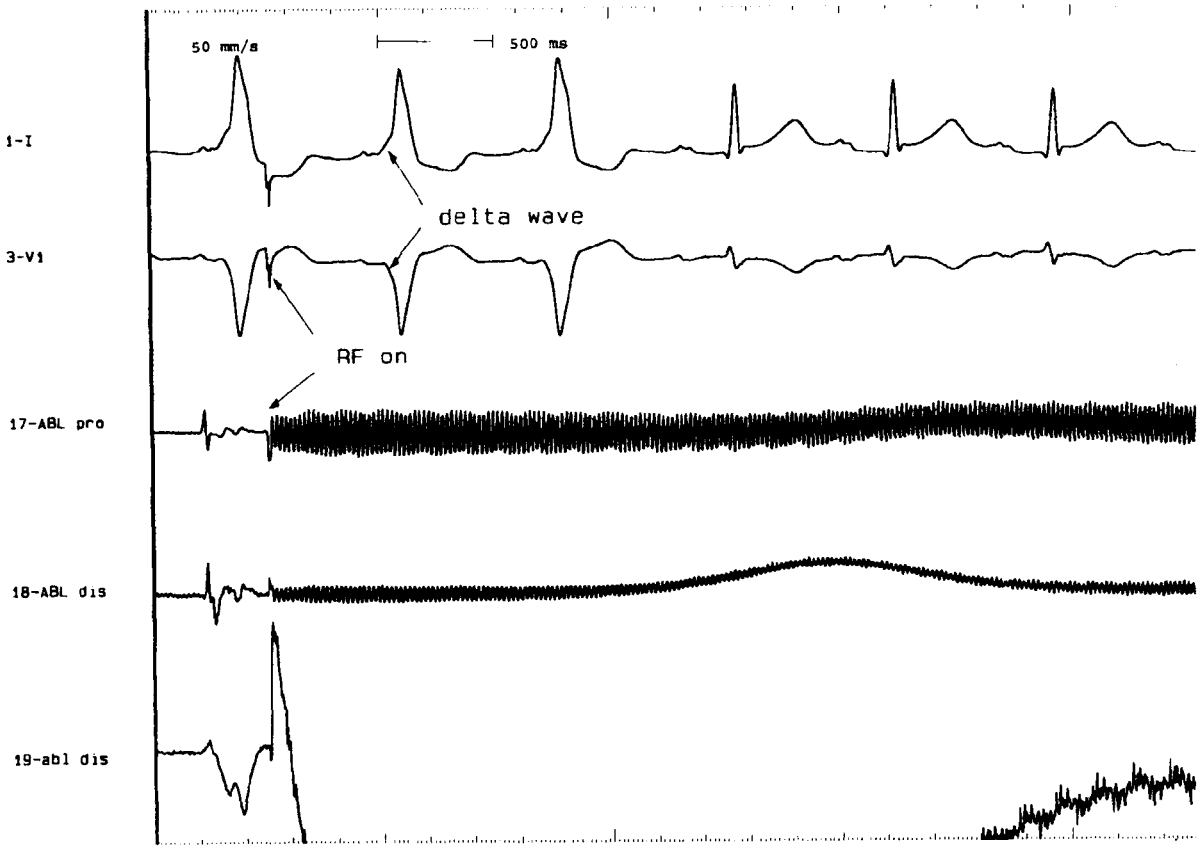

Fig. 3. Electrograms from a patient with right free wall accessory pathway are shown. Radiofrequency current is applied to the accessory pathway site during sinus rhythm. There is almost immediate loss of the delta wave indicating conduction block in the accessory pathway.

hypertrophic cardiomyopathy, one dilated cardiomyopathy one atrial septal defect and one coronary artery disease.

Location of bypass tracts

Eleven patients (13.3%) had multiple bypass tracts: nine had 2 bypass tracts, one had 3 bypass tracts and one had 4 bypass tracts. A total of 98 bypass tracts were demonstrated in 83 patients. Eighty-four bypass tracts were antegrade type, whereas, 14 bypass tracts were concealed type (or bypass tract that can conduct only in the retrograde direction). We described only bypass tract that can conduct antegradely. The bypass tracts were classified into 4 major locations: left free wall, right free wall, anteroseptal and posteroseptal. Twenty-eight bypass tracts (33.3%) were located at the left free wall: 19 (22.6%) right free wall, 8 (9.5%) anteroseptal, and 29 (34.5%) posteroseptal region. Thirty-six bypass tracts (43%) were left sided and 48 (57%) right sided. Distribution of bypass tract locations are shown in Fig. 4. There was no significant difference in severity of symptoms namely frequency of attack, syncope or presyncope between patients with left sided and right sided bypass tract. However, patients with right sided bypass tract were associated more often with structural heart disease than those with left sided bypass tract (25% *vs* 2.9%, p = 0.006).

Results of EPS and RFCA

SVT was induced in 97 per cent of patients in EP lab. Inducible arrhythmias were ORT in 92 per cent of patients, antidromic reciprocating tachy-

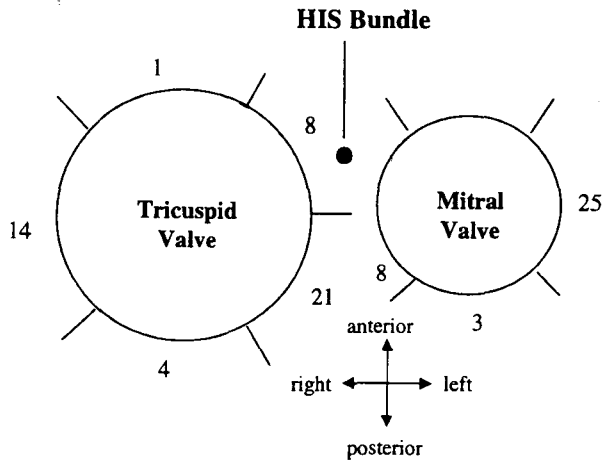

Fig. 4. Schematic diagram illustrating the location of the 84 accessory pathways. For each location the total number of accessory pathways is given.

cardia (ART) in 14.5 per cent and atrial fibrillation in 21 per cent. Average SVT cycle length during ORT or ART was 370±9.4 msec. RFCA was successful in 95.2 per cent of patients. Locations of the bypass tract in which ablation was not successful were at the right posteroseptal in 3 and right anteroseptal in 1. The average time of procedure was 144.4±8.4 minutes and for fluoroscopy 49.7±4.9 minutes. The mean radiofrequency power for successful ablation was 31.9±1.5 watts and the median number of applications was 7. The ventricular signal at the site of successful ablation was 36.9±1.8 msec earlier than the onset of delta wave. In the patients with successful ablation, ECG returned to normal in 4.8± 0.7 seconds and the accessory pathway potential could be demonstrated in 27.7 per cent. Two patients (2.4%) developed complications: one having a large hematoma at the venous puncture site and the other one had mild pericardial effusion.

Comparison of data among different bypass tract locations

The results of RFCA are shown in Table 1. Our findings showed that the procedure and fluoroscopy took longer in RFCA of the right free wall than others. Radiofrequency power was higher for right free wall than others and the right free wall needed more attempts of radiofrequency applications than other locations.

Comparison between left sided and right sided bypass tract

Our results showed that the success rate of ablation of the left sided bypass tract was better than the right (100% *vs* 89.7%, p = 0.06). Right sided bypass tract needed more radiofrequency power (26.6±1.7 *vs* 38.4±2.5, p < 0.001) and greater number of radiofrequency applications than left sided (9.9±1.9 *vs* 16±3.0, p = 0.09).

Table 1. Characteristics of bypass tract at various locations and results of RFCA.

	Left Free wall (n=28)	Right Free wall (n=19)	Anteroseptal (n=8)	Posteroseptal (n=29)
Age	34.4±2.9	32.6±4.0	25.7±6.4	41.8±2.7
% Male	25	56.3	66.7	64
% Heart Disease	0	26.3	0	27.6
% Successful Abl	100	100	85.7	89.7
% Complication	7	0	0	0
% ART	4.5	6.3	0	20
% Recurrence	3.7	26.3	12.5	10.3
Procedure Time*	128.6±13.5	191.1±18.9	150.8±30.3	122.7±10.7
Fluoroscopy Time	45±7.5	81.6±11.4	36.3±11.8	32.9±5.5
No of Attempt*,**	6 (1-50)	19 (1-84)	2 (1-18)	5 (1-27)
RF Power*	26.3±1.9	45±2.3	32.5±10.3	30.5±3.0

ART = antidromic reciprocating tachycardia, RF = radiofrequency, Successful Abl = successful ablation
* $p < 0.05$
** use median value (range)

Comparison between patients with multiple bypass tracts and those with single tract

There were no differences in age, gender, severity of symptom or associated heart disease between patients with multiple bypass tract and single tract. However, patients with multiple bypass tract had longer duration of symptoms than those with single tract (132.0±25.5 *vs* 76.7±10.4 months, $p < 0.05$). Inducible antidromic tachycardia during EP study occurred more often in patients with multiple bypass tract compared to those with single tract (50% *vs* 8.5%, $p = 0.001$). As expected, the procedure and fluoroscopy time were longer in patients with multiple bypass tract than those with single tract (199.8±28.2 *vs* 144.4±8.4 minutes and 77.0±15.9 *vs* 49.7±4.9 minutes, $p < 0.05$). All patients with multiple bypass tract were successfully ablated.

Recurrence of WPW syndrome and results of repeated RFCA

The average time of follow-up after RFCA was 20.7±1.3 months. Ten patients (12%) had recurrence of WPW syndrome. The median duration of recurrence was 1 month. All of them recurred with bypass tract from the same location. All of them were successfully reablated. Recurrence rate was more often on the right sided bypass tract than the left (18.8% *vs* 2.9%, $p = 0.028$). Structural heart disease was found more often in patients who had recurrence of WPW syndrome (30.8% *vs* 8.6%, $p = 0.024$). In one patient with right posteroseptal bypass tract RFCA was successfully performed 3 months after unsuccessful ablation. The overall successful RFCA result was 96.4 per cent. In one patient with right anteroseptal bypass tract, the conduction disappeared temporarily, therefore, RFCA was rescheduled and successfully performed. Table 2 shows the characteristics of patients in the recurrent group.

Association with other types of cardiac arrhythmia

Four patients had other associated cardiac arrhythmias: one had atrial tachycardia, one frequent premature ventricular complexes (PVC) from right ventricular outflow tract (RVOT), and two others AV nodal reentry (AVNRT). AVNRT was successfully ablated in both patients. Atrial tachycardia and PVC were not treated because they were asymptomatic.

DISCUSSION

We described characteristics and outcome of RFCA of 83 patients with WPW syndrome treated at Siriraj Hospital which is a tertiary center in Thailand. Most of our patients were adults. Characteristics of patients in this study are similar as those described in other studies except the gender distributions which are almost equal for male and female in the present study but are twice as frequent in males in other reports[10,12,18]. Regarding bypass tract location, right sided bypass tract was found more often in this study but less

Table 2. Characteristics of patients who had recurrence of bypass tract conduction.

Patient Number	Age (year)	Sex	Heart Disease	AP location	Ablation Date (m/y)	Time to Recur	Number of AP
1	70	F	No	RPS	6/95	17 m	2
2	31	F	Ebstein's	RPS	1/96	30 m	2
3	48	F	Ebstein's	RPS	2/97	2 d	1
4	10	F	ASD	RL	2/97	2 m	1
5	48	M	No	RAS	3/97	5 d	1
6	22	M	No	RL	9/97	12 d	1
7	16	F	No	RL	12/97	1 m	1
8	57	F	No	RL	1/98	1 m	1
9	41	M	No	LL	5/98	5 m	1
10	44	M	DCM	RL	9/98	6 d	1

AP = accessory pathway, ASD = atrial septal defect, d = day, DCM = dilated cardiomyopathy, F = female, LL = left lateral, M = male, m = month, m/y = month/year, RAS = right anteroseptal, RL = right lateral, RPS = right posteroseptal, Time to recur = time to recurrence

Table 3. Comparison of results of RFCA from this study with previous studies.

Reference	No of Patients	%Success	%Recurrence	%Complication
Jackman et al [7]	166	98.8	8.3	3
Kay et al [8]	363	95.3	5.2	1.1
Haissaguerre et al [9]	186	96.8	2.5	1.6
Swartz et al [10]	114	98.2	8.2	3.5
Saul et al [11]	71	93	15.5	11.3
Schluter et al [12]	92	85.9	3.8	3.3
Calkins et al [13]	250	94	6.8	3.6
Leather et al [14]	75	71.7	11.7	5.3
Chen et al [15]	150	91.3	3.6	NA
Krittayaphong et al	83	96.4	12	2.4

often than left sided in other studies. Distribution of bypass tract location from previous studies is: 40-60 per cent within the left free wall space, 25 per cent in the posteroseptal space, 13-21 per cent in the right free wall space and 2-6 per cent in the anteroseptal space[3,7,18]. In the present study, distribution of bypass tract location in these regions was less prevalent in the left free wall space (33.3%) and more on the right free wall (22.6%), posteroseptal (34.5%) and anteroseptal space (9.5%). Approximately 16 per cent of our patients had associated structural heart disease and 13.3 per cent had multiple bypass tracts which are similar to data from previous reports[19]. Most commonly associated heart disease was Ebstein's anomaly which was found in 6 patients in our study (7%). Right sided bypass tract was more oftenly associated with structural heart disease than left sided.

Overall success rate of RFCA was 96.4 per cent. There was no significant difference in the success rate among different bypass tract locations. Successful rate may depend on learning experience since the failures occurred only in the early years. The success rate was 100 per cent during 1997 and 1998. Although we had more right sided bypass tracts compared to other reports our success rate was still very high.

Table 3 shows results from several large series reporting on the RFCA of accessory pathways compared to our study. The technical approach for RFCA in various studies is virtually similar. Although some electrophysiologists[7] believe that AP potential has an essential role for successful ablation others prefer to use early activation of local electrogram. We can summarize from Table 3 that the success rate of RFCA for WPW syndrome at Siriraj Hospital was comparable to previous reports from Western countries[7-14] and one report from Taiwan[15] with a low complication rate. Unfortunately we don't have data from other Asian countries for comparison.

In conclusion we have shown from this study that in the Thai population RFCA is a very effective treatment option for patients with WPW syndrome. Although the recurrence rate was 12 per cent, all patients with recurrent WPW syndrome were successfully reablated.

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การรักษา Wolff–Parkinson–White syndrome โดยวิธี Radiofrequency Catheter Ablation: รายงานคนไข้ 83 รายจากโรงพยาบาลศิริราช

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ได้ทำการศึกษาผู้ป่วย Wolff–Parkinson–White (WPW) syndrome 83 คนที่มีอาการและได้รับการรักษาโดยวิธี Radiofrequency Catheter Ablation (RFCA) ที่โรงพยาบาลศิริราช RFCA สามารถรักษาได้ผลถึง 96.4% โดยมีภาวะแทรกซ้อนน้อยมาก หลังจากได้รับการรักษาโดยวิธี RFCA แล้ว ผู้ป่วยไม่จำเป็นต้องทานยาใด ๆ อีก แม้ว่าจะมีอัตราการกลับเป็นใหม่ 12% ผู้ป่วยที่กลับเป็นใหม่ทุกคนได้รับการรักษาซ้ำสำเร็จโดยวิธี RFCA โดยสรุป RFCA เป็นวิธีที่ดีที่สามารถใช้รักษาผู้ป่วย WPW syndrome ควรพิจารณารักษาวิธีนี้ในผู้ป่วย WPW syndrome ที่มีอาการจากหัวใจเต้นผิดปกติ โดยเฉพาะในรายที่ไม่ตอบสนองต่อการใช้ยา

คำสำคัญ : Radiofrequency Catheter Ablation, WPW Syndrome

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