Radiofrequency Catheter Ablation: 5 Years Experience at Siriraj Hospital

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Abstract

Between February 1995 to May 2000, 626 consecutive patients underwent radiofrequency catheter ablation for various types of cardiac arrhythmia. The mean age was 41 years, range 1-85 years. Mapping and ablation were guided by intracardiac electrogram and anatomical approaches. The initial success, compliction, recurrent and final success rates are shown below :-

	WPW	AVRT	AT	AFl	AVNRT	PVC	VT	AF
Initial success (%)	95	100	83	91	100	89	95	81
Complication (%)	2.1	4.6	7.1	8.8	6.0	7.7	1.4	25
Recurrence (%)	9	4	13	6	1	11	11	6
Final success (%)	93	99	77	88	100	89	91	75

Conclusion, RFCA is an effective treatment and should be considered as first line treatment for certain tachyarrhythmia.

Key word : Radiofrequency Catheter Ablation, Cardiac Arrhythmia

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Ganzalez[1], 1981, reported the successful result of closed-chest catheter ablation by using high voltage shock from the standard defibrillator to create atrioventricular (AV) block in dogs. Scheinman[2] and Gallagher[3] applied this technique to produce AV block in patients with refractory supraventricular tachycardia (SVT). This direct current shock used a high-energy shock, ranged from 100 to 400 joules per shock. The delivered shock produced a small explosion at the catheter tip with high temperature heat, barotrauma and electrical injuries to the underlying tissue, causing depressive ventricular function or cardiac perforation[4-7] which limited its widespread application.

The concept of radiofrequency (RF) energy was introduced in 1891 in order to avoid the undesirable effect of neuromuscular stimulation during surgical procedures[8]. The first clinical use took place by the neurosurgery for the purpose of electrocoagulation in 1929[9]. Huang et al, 1985, reported the first use of RF energy as an alternative energy source for closed chest canine ablation[10] and applied it to humans in 1986[11]. Because of easy performation without general anesthesia, less complication, high success rate and low rate of recurrence than direct current shock catheter ablation, it has become the first-line therapy for various types of tachyarrhythmias, both SVT and ventricular tachycardia (VT)[12-19]. The aim of this study was to report the results of radiofrequency catheter ablation (RFCA) at Siriraj Hospital from the first time experience to the present.

PATIENTS AND METHOD

From February 1995 to May 2000, there were 626 consecutive patients who were referred to Siriraj Hospital for management of symptomatic tachyarrhythmia, both supra and ventricular in origins. The mean age was 41 years, range 1-85 years. The ratio between male and female genders was 1:1.7. The most common symptom during tachycardia was palpitation (96%). The other symptoms were presyncopy (11%), syncope (7%), chest pain (6%), dyspnea on exertion (4%) and dizziness (2%). One hundred and thirty one patients (20%) had underlying disease, as shown in Table 1.

Electrophysiologic study, mapping and ablation

After obtaining informed written consent from all patients, an invasive electrophysiology study was performed in the fasting state and after discontinuation of all antiarrhythmic agents for more than three half-lives, except amiodarone which was discontinued for two months. Under local anesthesia, 3 quadripolar electrode catheters were advanced under fluoroscopic guidance from the right femoral vein and placed in the high right atrium, His position and the apex of the right ventricle. For coronary sinus mapping, an octapolar catheter was inserted into this vessel *via* right internal jugular or subclavein vein. After 1997, we used a 7 or 8 Fr quadripolar electrode with defectable tip catheter as His recording catheter. If the shortest atrioventricular or ventriculoatrial conduction did not detect anything at the His or mid-line position, then this catheter was moved and inserted into the coronary sinus for coronary sinus mapping. Surface ECG leads I, aVL, V_1 and V_6 and intracardiac electrograms were simultaneously displayed and recorded on a multichannel oscilloscopic recor-

Table 1. Underlying diseases of the population.

Underlying disease	No (%)
Cardiac	84 (64.1)
Valvular	27 (20.6)
Prolapsed mitral valve	23
Mitral stenosis	3
Aortic regurgitation	1
Cardiomyopathy	23 (17.5)
Dilated	21
Hypertrophic	2
Congenital	24 (18.3)
Ebstein	13
Atrial septal defect	4
Tetralogy of Fallot	3
Subaortic stenosis	1
Double outlets of left ventricle	1
Persistent left SVC	1
Congenital long QT	1
Ischemic heart disease	6 (4.6)
Sick sinus syndrome	3 (2.3)
Myocarditis	1(0-8)
Non cardiac	47 (35.9)
Hypertension (HT)	22
Diabetes millitus (DM)	8
HT and DM	4
Pulmonary	
Asthma	4
Obstructive lung disease	3
Chronic renal failure	2
Cirrhosis liver	1
Thalassemia	1
Scleroderma	1
Idiopathic thrombocytopenia	1

der (ART and EP Inc). Programmed electrical stimulation, mapping and ablation were performed as previously described from our laboratory[20-24] and elsewhere[12-17]. Briefly, for accessory pathway, we used the shortest atrioventricular and ventriculoatrial conduction times, during antagrade and retrograde conduction, respectively, as the target site for ablation. For atrial tachycardia (AT), a double catheter technique was used for right atrial mapping and a transatrial septal approach for left atrial mapping. We tried to identify the earliest site of atrial activation which presummed the origin of ectopic atrial tachycardia. For atrial flutter type I (AFl) and atrioventricular nodal reentry tachycardia (AVNRT), we used an anatomical approach for ablation at the isthmus between tricuspid annulus (TA) and inferior vena cava (IVC) and slow pathway, respectively. For ventricular arrhythmia, we used both the earliest endocardial activation time and pace mapping to identify the site for ablation. Finally, for atrial fibrillation (AF) we used Biosense electroanatomical mapping system[25] in order to reconstruct the left and right atria, pulmonary veins (PV), superior (SVC) and inferior vena cava, tricuspid and mitral annual. Ablation was done by the anatomical approach to create 3 lines of conduction blocks in each atrium. For the left atrium, the lines of conduction blocks were created from right and left upper to lower pulmonary veins, extended to the mitral annulus in both sides and between right and left superior pulmonary veins. For the right atrium, we created lines of conduction blocks from SVC to IVC, TA to IVC and encircled at mid level.

After localizing the target site for ablation and intravenous infusion of fentanyl and propofol, an RF current of 15-65 watts was delivered between the distal pole of the ablation catheter and a large surface-area skin patch placed over the left scapula for 20-60 seconds, or until there was a sudden increase in impedance indicative of coagulum formation. If tachycardia terminated within 15 seconds after the beginning of the RF application, the RF current was continued to 60 seconds. Programmed stimulation was repeated immediately and after 30 minutes after successful ablation, to confirm the absence of inducible tachyarrhythmia before removing all catheters and sheaths.

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

Follow-up

After the ablation procedure, all patients were monitored continuously in hospital for 24-48 hours. Echocardiography was performed before hospital discharge without antiarrhythmic agents. All patients were evaluated by the investigators on a regular basis, every 2-4 weeks in the first few months and every 3 months after that, in order to detect the recurrence.

RESULTS

There were 647 ablative procedures from 626 patients as shown in Tables 2 and 3. Four hundred and eighty seven patients (77.7%) had

Table 2. Numbers of radiofrequency catheter ablation classified by types of arrhythmia.

	WPW	AVRT	AVNRT	AT	AFl	PVC	VT
Total cases	144	86	165	42	34	65	74
Total tracts	151	90	165	47	34	70	74
Ablation							
Success (%)	143(95)	90(100)	165(100)	39(83)	31(91)	62(89)	70(95)
Failure (%)	8(5)	-	-	8(17)	3(9)	8(11)	4(5)
Recurrence (%)	13(9)	4(4)	2(1)	5(13)	2(6)	7(11)	8(11)
Reablation (Recur)	11	3	2	3(1)	1	7	5
Final success (%)	93	99	100	77	88	89	91

WPW = Wolff- Parkinson – White; AVRT = Atrioventricular reciprocating tachycardia; AVNRT = Atrioventricular nodal reentrant tachycardia; AT= Atrial tachycardia; Afl = Typical atrial flutter ; PVC = Premature ventricular contraction; VT = Ventricular tachycardia.

Table 3. Radiofrequency catheter for atrial fibrillation (AF).

	No	Convert to sinus	Recur
Total	16	13	1
Type of ablation			
AV node modification	1	-	-
Linear ablation			
Right atrium (RA)	2	-	-
Left atrium (LA)	2	2	-
RA+LA	8	8	1
Focal			
Left atrium	3	3	-

Table 4. The complications of radiofrequency catheter ablation.

	No	%
Pericardial effusion (by ECHO)	7	1.11
First degree AV block	4	0.64
Respiratory insufficiency	4	0.64
Cardiac tamponade	3	0.48
Third degree AV block	3	0.48
Death	3	0.48
Congestive heart failure	2	0.32
Pulmonary embolism	2	0.32
Complete right bundle branch block	2	0.32
Groin hematoma	2	0.32
Cerebral embolism	1	0.15
Total	33	5.26

supraventricular tachycardia. Most of them were AVNRT. The remainder (22.3%) was ventricular arrhythmia.

The initial success, failure, recurrence, reablation and final success rates are showed in Table 2. The highest and lowest final success rates were AVNRT and AT, respectively. Among 16 patients who underwent AF ablation, 3 had focal AF from right and left upper pulmonary veins: Two patients who had only right atrial ablation and one who had AV nodal ablation and a permanent pacemaker implantation remained AF, while 12 patients who had left atrial ablation alone, pulmonary veins ablation, or biatrial ablation had sinus rhythm for an average of 6 months after ablation.

The overall complication in our experiences was 5.3 per cent (Table 4). The most common complication was pericardial effusion detected by echocardiography. Death occurred in 3 patients from WPW, AT and AF ablation in each one. Pulmonary embolism occurred in 2 patients who underwent AF ablation. Cardiac tamponade occurred in 3 patients, 2 AVNRT and 1PVC ablation. Two of them, AVNRT and PVC in each one, needed surgery. Three patients, 2 AVNRT and 1 AVRT, had third degree AV block but only 2 patients (AVNRT) needed permanent pacemaker implantation. Congestive heart failure occurred in 2 patients, 1 AT and 1 left VT, who had tachycardia induced cardiomyopathy. Cerebral embolism developed in 1 AF and 4 respiratory insufficiency in patients who had pulmonary disease before ablation.

DISCUSSION

Main finding: The results of this study showed that RFCA, using intracardiac electrogram and anatomical guided approaches, for various f orms of tachyarrhythmia is highly effective and safe. The overall final success and recurrent rates were 96 and 6.7 per cent, respectively. Reablation could also be performed with a high success rate. Recently, RFCA has become the first choice for WPW, AVRT, AVNRT, typical AFl and bundle branch reentry VT[18,19]. It is also an acceptable alternative method for various arrhythmias that are resistant to antiarrhythmic agents, including AT, idiopathic right and left VT and atrial fibrillation. For PVC from right ventricle outflow tract patients who were highly symptomatic, RFCA should be the initial therapy because our success rate was 89 per cent with low complication rate (1.5%), but more experience is required. RFCA for AF, both linear and focal ablation, is also feasible but the complication in our study is high because it is our learning experience.

Complication of RFCA: The overall complication rate in this study was 5.3 per cent. Atrial fibrillation ablation had the highest complication rate (Table 5). This might be our early learning period and the ablation technique needed the longest procedure time: 6-8 hours compared to 2-3 hours for other arrhythmic ablations. However, after the concept of focal AF ablation[26,27], we tried to ablate ectopic atrial foci from pulmonary veins in patients who had paroxysmal atrial fibrillation. This decreased the procedure time to 4-6 hours.

Comparison with previous studies: Our study had similar efficacy as previous reports, i.e.,

Table 5. Major and minor complication classified by types of arrhythmia.

Arrhythmia	No	Minor		Major		Total	
		No	%	No	%	No	%
WPW	144	2	1.4	1	0.7	3	2.1
AVRT	86	2	2.3	2	2.3	4	4.6
AT	42	-		3	7.1	3	7.1
AFl	34	2	5.9	1	2.9	3	8.8
AF	16	-		4	25	4	25
AVNRT	165	5	3.0	5	3.0	10	6.0
PVC	65	4	6.2	1	1.5	5	7.7
VT	74	-		1	1.4	1	1.4
Total		15	2.4	18	2.9	33	5.3

more than 95 per cent for AVNRT, AVRT, WPW and idiopathic VT; 80-90 per cent for AT and AFl type I and 80 per cent for AF. However, our complication was some what higher than previous studies. This may be due to 20 per cent of our patients having underlying disease, our learning curve and using anesthetic agents during ablative procedures, especially in patients who were prone to develop complications such as dilated cardiomyopathy, pulmonary, renal and hepatic diseases.

SUMMARY

Our data demonstrated that RFCA could be a highly successful procedure for the treatment of various types of cardiac arrhythmias, including PVC and AF. Although the complication was rather high, it was in acceptable range. RFCA should be considered as the first line treatment of supraventricular tachycardia eg. WPW, AVRT, AVNRT AFl type I and AT, and ventricular arrhythmia, eg. PVC from RVOT and idiopathic VT.

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การรักษาภาวะหัวใจเต้นผิดปกติโดยการจี้หัวใจด้วยไฟฟ้าความถี่สูงเท่าคลื่นวิทยุ : ประสบการณ์ 5 ปี ที่โรงพยาบาลศิริราช

องค์การ เรืองรัตนอัมพร, พ.บ., เกียรติชัย ภูริปัญโญ, พ.บ.*, ชาญ ศรีรัตนสถาวร, พ.บ.*, รุ่งโรจน์ กฤตยพงษ์, พ.บ.**, จารุพิมพ์ สูงสว่าง, พ.บ.***, ศุภชัย ไชยธีระพันธ์, พ.บ.***

คณะผู้วิจัยได้รายงานผลการรักษาภาวะหัวใจเต้นเร็วผิดปกติด้วยการใช้คลื่นไฟฟ้าความถี่สูงเท่าคลื่นวิทยุในผู้ป่วย 626 ราย (647 การลัดวงจรไฟฟ้าหัวใจ) อายุเฉลี่ย 41 ปี ได้ผลดังนี้

	WPW	AVRT	AT	AFl	AVNRT	PVC	VT	AF
ผลสำเร็จระยะแรก (%)	95	100	83	91	100	89	95	81
ภาวะแทรกซ้อน (%)	2.1	4.6	7.1	8.8	6.0	7.7	1.4	25
การเป็นกลับ (%)	9	4	13	6	1	11	11	6
ผลสำเร็จสุดท้าย (%)	93	99	77	88	100	89	91	75

ดังนั้นการรักษาภาวะหัวใจเต้นเร็วผิดปกติบางชนิดอาจใช้การจี้หัวใจด้วยคลื่นไฟฟ้าความถี่สูงเป็นการรักษาระดับแรก

คำสำคัญ : Radiofrequency Catheter Ablation, Cardiac Arrhythmia

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