

Cost Effectiveness of Radiofrequency Catheter Ablation Versus Medical Treatment for Paroxysmal Supraventricular Tachycardia in Japan

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Abstract

This study evaluated the cost of performing radiofrequency catheter ablation in Japanese patients with paroxysmal supraventricular tachycardia refractory to antiarrhythmic drug therapy in comparison with the cost of continuing pharmacologic treatment. Twenty patients (mean age 44 ± 14 years) underwent successful ablation: 15 patients with Wolff-Parkinson-White syndrome and five with atrioventricular nodal reentrant tachycardia. The mean duration of symptoms was 77 ± 60 months. The patients had been treated with 2.6 ± 1.7 antiarrhythmic drugs before undergoing ablation. Charges derived from hospital bills were compared with the outpatient charges for the year before ablation. The mean hospital stay for the ablation procedure was 4.3 ± 0.5 days. The mean total charge for ablation was $\text{¥}982,806 \pm 103,195$, and 5.7 ± 0.7 times the outpatient charges in the previous year. The majority of radical cure charges were the costs of the electrode catheters used in the ablation procedure. All patients had a successful outcome and required no additional antiarrhythmic drug therapy. If medical treatment were continued without ablation, the mean total life-expectancy charges were estimated at $\text{¥}7,064,726 \pm 3,116,621$, 41.0 ± 19.2 times the outpatient charges. The total life charges of medical treatment were significantly more than the total ablation charges ($p < 0.001$). This study suggests that radiofrequency catheter ablation is of clinical benefit in treating paroxysmal supraventricular tachycardia, and markedly reduces the cost of definitive therapy. This strategy appears to be more economical than pharmacologic treatment.

Key Words

radiofrequency catheter ablation, antiarrhythmic drug, paroxysmal supraventricular tachycardia, cost effectiveness

INTRODUCTION

The Wolff-Parkinson-White syndrome (WPW syndrome) and atrioventricular nodal reentrant tachycardia are the most common causes of paroxysmal supraventricular tachycardia^{1,2)}. For many years, pharmacologic treatment was the only means

available for managing these tachyarrhythmias. Antiarrhythmic therapy has limitations, including inefficacy, intolerance, and the necessity for long-term administration, so nonpharmacologic treatment has become increasingly important as a therapeutic alternative.

Catheter ablation using radiofrequency energy

Table 1 Symptoms and antiarrhythmic drugs in patients undergoing successful radiofrequency catheter ablation

Patient No.	Age (yrs)	Sex (male/female)	Diagnosis of tachyarrhythmias	Symptoms during tachycardia	Antiarrhythmic drugs administered before ablation
1	21	M	A type manifest WPW, Paf	Dizziness	DP, <u>PCA</u> , <u>PRO</u> , VER
2	47	M	Concealed WPW	Palpitation	<u>VER</u>
3	56	F	A type intermittent WPW, Paf	Syncope	Q, DP, PCA, CIB, PRF, <u>PIL</u> , VER
4	36	F	A type manifest WPW	Palpitation	DP, <u>PCA</u> , <u>PRO</u>
5	33	M	Common form AVNRT	Palpitation	<u>VER</u>
6	50	M	C type intermittent WPW, Paf	Palpitation	Q, DP, PCA, CIB, APR, <u>PRE</u> , VER
7	60	F	Concealed WPW	Palpitation	DP, <u>VER</u>
8	48	M	Concealed WPW	Palpitation	<u>VER</u>
9	52	F	A type intermittent WPW, Paf	Dizziness	<u>DP</u>
10	47	F	Common form AVNRT	Palpitation	<u>VER</u>
11	60	M	Concealed WPW	Chest oppression	<u>PRO</u> , <u>VER</u>
12	48	M	Concealed WPW	Palpitation	DP, <u>VER</u>
13	46	M	A type manifest WPW, Paf	Dizziness	<u>DP</u>
14	45	M	Common form AVNRT	Palpitation	DP, PCA, <u>VER</u> , DIG
15	32	M	A type intermittent WPW	Palpitation	DP, PRO, <u>FLE</u>
16	28	M	C type manifest WPW, Paf	Palpitation	<u>DP</u>
17	64	F	Common form AVNRT	Palpitation	DP, <u>VER</u>
18	72	F	B type manifest WPW	Palpitation	<u>DP</u> VER, DIG
19	67	M	A type manifest WPW, Paf	Palpitation	DP, PCA, APR, <u>PIL</u>
20	30	F	Common form AVNRT	Palpitation	<u>VER</u>

Antiarrhythmic drugs underlined were administered just before ablation procedure.

WPW = Wolff-Parkinson-White syndrome; AVNRT = atrioventricular nodal reentrant tachycardia; Paf = paroxysmal atrial fibrillation; Q = quinidine; DP = disopyramide; PCA = procainamide; CIB = cibenzoline; APR = aprindine; PRO = propranolol; PRF = propafenone; PIL = pilsicainide; FLE = flecainide; VER = verapamil; DIG = digoxin

has been used safely and successfully to eliminate accessory pathways in patients with WPW syndrome³⁻⁶ and to modify atrioventricular nodal reentrant tachycardia⁷⁻¹⁰. This treatment has a high degree of patient acceptance because it eliminates the need for open-chest surgery. An additional advantage is the anticipated cost savings, although little data on the economic aspects have been published.

The purpose of this study was to evaluate the cost of radiofrequency catheter ablation in Japanese patients with a long history of symptomatic paroxysmal supraventricular tachycardia refractory to antiarrhythmic drug therapy, and to compare the cost with that of continued pharmacologic treatment alone.

METHODS

Patient characteristics

Twenty patients who underwent successful radiofrequency catheter ablation of paroxysmal supraventricular tachycardia at Ohashi Hospital of Toho University between July and December 1992 were selected (Table 1). Radiofrequency catheter

ablation was performed after patients gave written informed consent. There were 12 men and 8 women aged 21-72 years (mean 44 ± 14 years). None of the patients had apparent structural heart disease. Fifteen of the 20 patients had WPW syndrome, while the others had atrioventricular nodal reentrant tachycardia. Manifest WPW syndrome was recognized in 6 patients, intermittent in 4, and concealed in 5. In patients with manifest and intermittent preexcitation, A type delta wave was recognized in 7 patients, B type in 1, and C type in 2. Seven patients with WPW syndrome had complicated atrial fibrillation. Twelve of the 15 patients with WPW syndrome had a high risk profile. The mean atrioventricular block cycle length of manifest accessory pathways was 252 ± 22 msec. The mean retrograde block cycle length of all accessory pathways was 244 ± 24 msec. The mean anterograde effective refractory period of manifest accessory pathways was $\leq 224 \pm 12$ msec. Four of the patients with atrioventricular nodal reentrant tachycardia had dual atrioventricular nodal physiology and another one had triple. All five patients with atrioven-

tricular nodal reentrant tachycardia indicated common form atrioventricular nodal reentry. The mean coupling interval during tachycardia in patients with atrioventricular nodal reentrant tachycardia was 284 ± 32 msec. All patients with atrioventricular nodal reentrant tachycardia had strong symptoms. Each patient continued to have symptomatic tachycardia despite antiarrhythmic drug therapy. The mean duration and number of episodes of symptoms caused by tachycardia were 77 ± 60 months (range, 3–300 months) and 12 ± 10 (range, 6–50 months), respectively. During tachycardia, 15 patients had rapid palpitation, 3 had dizziness, 1 had chest oppression, and 1 had syncopal episodes. The patients had been treated with 1–7 antiarrhythmic drugs (mean 2.6 ± 1.7) before undergoing radiofrequency catheter ablation. Disopyramide (300–400 mg/day) was used in 14 patients, procainamide (2,000–3,000 mg/day) in 6, quinidine (600 mg/day) in 2, cibenzoline (300 mg/day) in 2, aprindine (40–60 mg/day) in 2, propranolol (30–60 mg/day) in 4, propafenone (450 mg/day) in 2, pilsicainide (150 mg/day) in 2, flecainide (200 mg/day) in 1, verapamil (120–240 mg/day) in 14, digoxin (0.25 mg/day) in 2. The mean duration of antiarrhythmic drug therapy was 54 ± 42 months (range, 3–180 months). Most drugs had been poorly tolerated or were ineffective. However, all patients with paroxysmal supraventricular tachycardia in this study needed to continue taking some drugs to decrease the incidence of symptoms. The mean number of prior electrophysiologic studies, performed for the management of paroxysmal supraventricular tachycardia, was 0.7 ± 0.7 (range, 0–2). Eight of the 20 patients underwent their first electrophysiologic study at the time of radiofrequency catheter ablation.

Baseline tests

Blood tests, a 12-lead electrocardiogram, a body surface mapping electrocardiogram, a chest X-ray film and an echocardiogram were performed on the first day of the hospital stay. The next day, patients underwent an initial electrophysiologic study for diagnosis and endocardial mapping. Radical cure with catheter ablation was attempted during the same session. All antiarrhythmic drug therapy was discontinued before the study.

For the electrophysiologic study, three multipolar electrode catheters were inserted into a femoral vein. A 5F quadripolar catheter (USCI, Billerica,

Massachusetts, USA) was positioned at the high right atrium, a 6F hexapolar catheter (Vygon, Aachen, Germany) at the His bundle area and a 5F bipolar catheter (Baxter, Irvine, California, USA) at the right ventricular apex. An additional quadripolar electrode catheter (Vygon, Aachen, Germany) was inserted into the medial cubital vein and positioned in the coronary sinus. A surface electrocardiogram (leads I, aV_F, V₁) and intracardiac electrograms were displayed on a multichannel oscilloscope and printed on a thermal recorder. Electrical atrial and ventricular stimulation was performed with a programmable digital stimulator (SEC-3102, Nihon Koden, Tokyo, Japan) to induce paroxysmal supraventricular tachycardia. If tachycardia was not initiated, the stimulation was repeated with infusion of isoproterenol.

Radiofrequency ablation procedure

After completing the diagnostic portion of the electrophysiologic study, radiofrequency catheter ablation was performed using a 7F quadripolar, steerable, large-tip catheter with a 4-mm distal electrode width and 2-mm interelectrode spacing (Mansfield-Webster catheters, Boston Scientific, Watertown, Massachusetts, USA). For the patients with left-sided or septal accessory pathways of WPW syndrome, the catheter was advanced from the femoral artery to the left ventricle and positioned in the lateral wall or septal wall under the mitral valve annulus. For the patients with right-sided accessory pathway or atrioventricular nodal reentrant tachycardia, the catheter was advanced from the femoral vein to the right atrium at the level of the tricuspid valve. In patients with atrioventricular nodal reentrant tachycardia, the slow pathway was targeted for ablation.

The radiofrequency energy was delivered by a 500-kHz generator (NL-50I, Central Kogyo, Chiba, Japan) with monitoring impedance available. Power was set at 25 watts and was applied for 20 sec. If this attempt did not abolish the accessory pathway or slow pathway, the catheter was repositioned at a new site and the power and delivery time were gradually increased up to 30 watts and 30 sec, respectively. Intravenous heparin was administered in an initial dose of 3,000 units at the onset of the procedure, and subsequent boluses of 1,000 units per hour were given throughout the procedure.

After ablation, serial measurements of creatine

phosphokinase (CPK) and electrocardiograms were obtained. A chest X-ray film and an echocardiogram were performed the day after ablation.

Cost analysis

All medical charges were obtained from the bills less health insurance payments sent to the patients by the hospital, and are expressed in yen. Technical charges for catheter ablation could not be claimed under the health insurance coverage between July and December 1992. The Japanese Health and Welfare Ministry determined a payment of ¥155,000 by the health insurance for the technical charges of catheter ablation from April 1994. However, charges for intracardiac electrograms and X-ray films based on the ablation procedure were reduced by about ¥50,000. Accordingly, ablation charges for each patient in the present analysis were corrected by an addition of ¥150,000. Any charges unrelated to the management of paroxysmal supraventricular tachycardia were excluded. The amounts billed to each patient during hospitalization for ablation were divided into radical cure (costs of the electrophysiologic study and ablation procedure), examination (costs of electrocardiograms, echocardiograms, chest X-ray films, and blood tests), and hospital charges (costs of room, board, nursing care, and drugs). The professional fees for performing ablation were not claimed in all patients at the Ohashi Hospital of Toho University. Ablation charges were compared with those for continued antiarrhythmic drug therapy, and were also expressed as a cost ratio based on the charges as outpatients during the year before ablation (base of 1.0). The total estimated charges for medical treatment for the rest of the patient's life were calculated by multiplying the annual cost for outpatients by their life expectancy (41 ± 19 years). The estimated life charges for these outpatients were divided into medication, examination, and miscellaneous charges.

Statistical analysis

All results are expressed as mean \pm standard deviation (SD). Cost comparisons were performed by the Wilcoxon method for paired values. A level of $p < 0.05$ was accepted as statistically significant.

Table 2 Duration of hospital stay and individual costs in 20 patients undergoing radiofrequency catheter ablation

Patient No.	Hospital stay (days)	Total ablation charges (¥)	Total estimated life charges (¥)
1	5	992,580	7,028,920
2	4	842,550	5,242,140
3	4	929,390	12,869,800
4	4	879,800	7,524,240
5	4	932,100	6,001,920
6	4	1,050,190	13,009,280
7	4	1,074,150	4,112,900
8	4	943,530	2,981,010
9	3	856,560	11,007,290
10	5	1,172,930	6,587,200
11	4	1,040,340	6,245,310
12	5	1,186,320	2,510,120
13	4	896,230	7,998,720
14	5	1,076,280	4,152,720
15	4	879,430	8,741,100
16	4	944,620	7,100,920
17	5	1,109,010	4,178,410
18	4	918,630	6,109,870
19	4	909,680	12,091,520
20	5	1,021,800	5,800,920
Mean \pm SD	4.3 ± 0.5	982,806 $\pm 103,195$	7,064,726 $\pm 3,116,621$

RESULTS

Hospitalization

The duration of the hospital stay for the ablation procedure was 3 to 5 days (mean 4.3 ± 0.5 days) (Table 2). The number of outpatient visits to the hospital during the year before ablation was 8–29 (mean 20.6 ± 6.2), and 0–6 emergency room visits (mean 1.2 ± 1.4) for episodes of paroxysmal tachycardia.

Efficacy of radiofrequency ablation

All patients had a successful outcome, and none required additional antiarrhythmic therapy. All pathways targeted for ablation were eliminated at the end of one session. The mean number of radiofrequency applications was 3.9 ± 3.5 (range, 1–15). The mean peak CPK after the ablation was 156 ± 104 IU/l (range, 41–508 IU/l; normal range, 50–150 IU/l). No complications occurred with this therapy.

An electrocardiogram, an echocardiogram, and a chest X-ray film performed on the day after the ablation revealed no new abnormalities attributable to

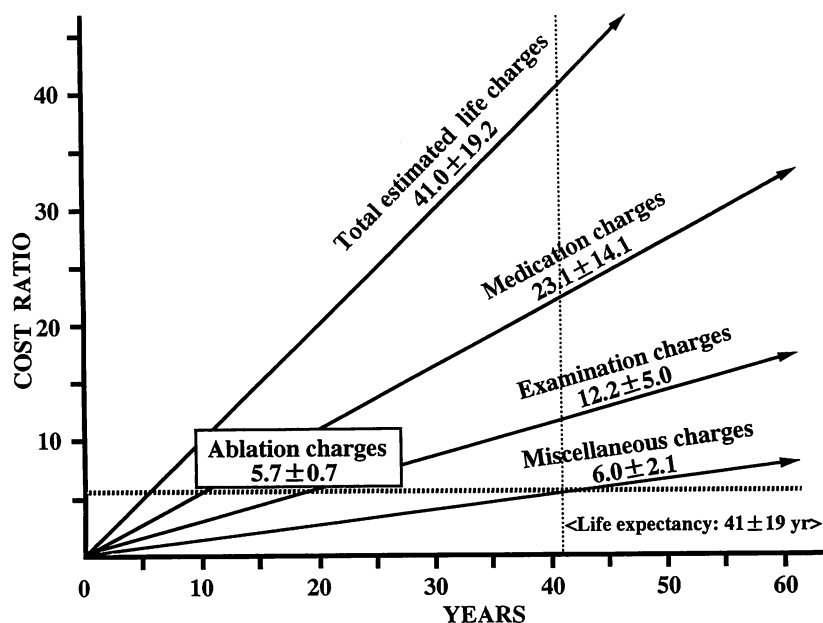


Fig. 1 Predicted total cost of long-term medical care for patients with paroxysmal supraventricular tachycardia compared with charges for radiofrequency catheter ablation of the anomalous pathways (broken line). Data are expressed as the mean cost ratio compared with the charges for medical treatment during the year before ablation.

Table 3 Cost ratios

	Cost ratio (n=20)
Radiofrequency ablation charges	5.7 ± 0.7
Radical cure charges	4.5 ± 0.5
Examination charges	0.3 ± 0.1
Hospital charges	0.9 ± 0.2
Total estimated life charges	41.0 ± 19.2* ¹
Medication charges	23.1 ± 14.1* ¹
Examination charges	12.2 ± 5.0* ²
Miscellaneous charges	6.0 ± 2.1* ³

All charges are expressed as a cost ratio in comparison with the charges for the outpatients during the year before ablation (designated as 1.0). Data are expressed as mean ± SD.

*¹ $p < 0.001$, *² $p < 0.01$, *³ $p < 0.08$ (compared with radiofrequency ablation charges)

the procedure. No episodes of paroxysmal supraventricular tachycardia occurred after the ablation procedure. Two of the 15 patients with WPW syndrome had palpitations attributed to paroxysmal atrial fibrillation, which had been recognized before the ablation procedure. Symptoms were mild and of short duration, and did not require antiarrhythmic drug therapy.

Costs data

The costs of definitive therapy by radiofrequency catheter ablation are listed in **Table 2**. The mean total charges for ablation were ¥982,806 ± 103,195,

comprised of radical cure charges of ¥775,899 ± 86,211, examination charges of ¥51,727 ± 17,269, and hospital charges of ¥155,180 ± 344,108. Most radical cure charges were for the electrode catheters used in the electrophysiologic study and the ablation procedure. The costs for medical treatment of the outpatients during the year before ablation were ¥172,422 ± 68,969. The total estimated life charges for outpatients continuing with medical treatment were ¥7,064,726 ± 3,116,621, comprised of medication charges of ¥3,981,701 ± 2,430,389, examination charges of ¥2,102,890 ± 861,840, and miscellaneous charges of ¥980,135 ± 360,973. The cost ratios compared with the outpatient charges for the year before ablation are shown in **Table 3** and **Fig. 1**. The annual cost for medical treatment of the outpatients was designated as 1.0. The mean cost ratio for total charges for ablation was 5.7 ± 0.7; showing that the total charges for the treatment was 5.7 ± 0.7 times as much as the outpatient charges for the year before ablation. However, the total estimated life charges for outpatients continuing with medical treatment averaged 41.0 ± 19.2. Therefore, the total ablation charge was about 14% of the total estimated charges of medical treatment that would be incurred throughout the patient's life. Medical charges for ablation therapy were significantly less than those with pharmacologic treatment ($p < 0.001$).

DISCUSSION

The radiofrequency catheter ablation procedure has been used safely and successfully to eliminate the anomalous pathway in patients with paroxysmal supraventricular tachycardia³⁻¹⁰. In our hospital, 74 of 81 patients (91%) have undergone successful ablation of paroxysmal supraventricular tachycardia without major complications¹¹. However, the cost effectiveness of curing the tachycardia by radiofrequency catheter ablation has not been sufficiently analyzed in Japan. This study showed that in patients with medically refractory paroxysmal supraventricular tachycardia, the total charges for radiofrequency catheter ablation were 5.7 times the costs incurred by patients during the year before ablation. However, the total ablation charges were only about 14% of the total estimated charges of continuing medical treatment throughout life. Although the short-term cost of the ablation procedure was high relative to the cost of antiarrhythmic drug therapy, over the long term the ablation procedure produces cost savings for patients with paroxysmal supraventricular tachycardia that does not terminate spontaneously. Thus, radiofrequency catheter ablation therapy dramatically reduced the medical costs of managing paroxysmal supraventricular tachycardia in patients with symptomatic episodes. Particularly in younger patients, the dramatic reduction in costs obtained with radiofrequency catheter ablation is obvious.

At the University of Michigan in the United States, radiofrequency catheter ablation was also demonstrated to cure paroxysmal supraventricular tachycardia at a cost that is less than that of the medical treatment^{12,13}. However, the total charges in the U.S. for ablation of paroxysmal supraventricular tachycardia adjusted to 1991 dollar values were \$14,919 ± 6,740 in patients with WPW syndrome and \$15,893 ± 3,338 in patients with atrioventricular nodal reentrant tachycardia, more than 1.5 times those of ablation therapy at our institution. The medical insurance system in the U.S. differs from that of Japan in demanding physician charges (professional fees) which are equal to half of the total ablation charges. Patients who underwent this procedure at our institution were not charged any professional fees by the hospital. Recently, the Japa-

nese Health and Welfare Ministry determined a payment of ¥155,000 for the technical charge of catheter ablation by the health insurance system. However, the technical charges for ablation in Japan are much less than those in the U.S.

Radiofrequency catheter ablation offers economic advantages to patients with paroxysmal supraventricular tachycardia refractory to medical treatment who require frequent emergency room visits or hospitalizations. Objections may be raised about this procedure for patients whose tachycardias are effectively controlled by medications. However, the cost considerations and the proarrhythmic actions and other side effects of the long-term antiarrhythmic drug therapy^{14,15} suggest that radiofrequency catheter ablation may be desirable for such patients.

Previous studies in the U.S. have demonstrated that radiofrequency catheter ablation of patients with paroxysmal supraventricular tachycardia is significantly less expensive than surgical approach^{13,16}. Those studies indicated the importance of the length of hospital stay in determining the cost of patient care. Kalbfleisch *et al.*¹⁷ demonstrated that radiofrequency catheter ablation of an accessory atrioventricular connection can be done safely and with cost savings, on an outpatient basis. Li *et al.*¹⁸ demonstrated that the use of antitachycardia pacing to treat paroxysmal supraventricular tachycardia reduced the monthly medical costs to the equivalent of the mean annual costs. Radiofrequency catheter ablation is less expensive than antitachycardia pacing^{13,18}, and appears to be the most cost-effective of the available therapies for managing patients with paroxysmal supraventricular tachycardia. Therefore, radiofrequency catheter ablation of paroxysmal supraventricular tachycardia can provide a reduction in the cost of definitive therapy.

CONCLUSIONS

This study indicates that radiofrequency catheter ablation of paroxysmal supraventricular tachycardia is of clinical benefit and dramatically reduces the medical costs of definitive therapy. Radiofrequency catheter ablation would appear to be more economical than pharmacologic treatment.

要 約

発作性上室性頻拍に対する高周波カテーテルアブレーション法と薬物療法の
経済面での比較検討

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薬剤抵抗性の発作性上室性頻拍に対する高周波カテーテルアブレーション法のわが国における治療費を検討し、アブレーション治療を行わず薬物療法が長期行われたと仮定した場合の医療費と比較することで、アブレーションの経済面での有用性を評価することとした。

対象は発作性上室性頻拍のためにアブレーションが施行され、頻拍を根治しえたと判断された20例(WPW症候群15例、房室結節リエントリー性頻拍5例)であり、平均年齢は47±14歳であった。頻拍発作の罹病期間は77±60ヵ月であり、アブレーション前に投与された各症例の抗不整脈薬数は2.6±1.7であった。医療費はすべて東邦大学大橋病院における保険請求額で計算し、また治療前1年間の頻拍管理に要した外来医療費をもとにその比率を示した。

その結果、アブレーション治療に必要であった入院期間は4.3±0.5日で、医療費は、総額982,806±103,195円で、外来医療費/年とのコスト比は5.7±0.7であった。アブレーション医療費の大部分は、電気生理学的検査とアブレーションに用いた電極カテーテルの費用によって占められた。全例アブレーションは成功と判断され、アブレーション後には薬物療法を中止しえた。一方、今後薬物療法が続行されたと仮定した場合の平均余命から概算した終身医療費は7,064,726±3,116,621円で、外来医療費/年とのコスト比は41.0±19.2であった。薬物療法続行時の終身医療費は、アブレーション施行時の医療費と比べ、有意に高額であった($p<0.001$)。

このことから発作性上室性頻拍への高周波カテーテルアブレーション法は、その有効性と安全性のみならず、経済面においても有用な治療法であることが示唆され、薬物療法が有効な症例においても考慮されるべき治療法であると考えられた。

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