Original Article

Radiofrequency Catheter Ablation of Atrioventricular Nodal Reentrant Tachycardia: Success Rates and Complications during 14 Years of Experience

Ahmad Yaminisharif, MD*, Gholamreza Davoodi, MD, Ali Kasemisaeid, MD, Ali Vasheghani Farahani, MD, Fatemeh Ghazanchai, Mansour Moghaddam, MD

Tehran Heart Center, Tehran University of Medical Sciences, Tehran, Iran.

Received 25 January 2010; Accepted 25 February 2010

Abstract

Background: *Radiofrequency catheter ablation (RFCA) has been introduced as the treatment of choice for supraventricular tachycardia. The aim of this study was to evaluate the success rate as well as procedural and in-hospital complications of RFCA for the treatment of atrioventricular nodal reentrant tachycardia (AVNRT).*

Methods: *Between March 1995 and February 2009, 544 patients (75.9% female, age: 48.89 ± 13.19 years) underwent 548 RFCAs for AVNRT in two large university hospitals. Echocardiography was performed for all the patients before and after the procedure. Electrocardiograms were recorded on digital multichannel systems (EP-Med) or Bard EP system. Anticoagulation was initiated during the procedure.*

Results: *From the 548 patients, 36 had associated arrhythmias, atrial flutter (4%), atrial fibrillation (0.7%), concurrent atrial fibrillation and atrial flutter (0.7%), and concealed atrioventricular pathway (0.4%). The overall success rate was 99.6%. There were 21 (3.9%) transient III-degree AV blocks (up to a few seconds) and 4 (0.7%) prolonged II- or III-degree AV blocks, 2 (0.25%) of which required permanent pacemaker insertion, 3(0.5%) deep vein thrombosis, and one (0.2%) arteriovenous fistula following the procedure. No difference was observed in the echocardiography parameters before and after the ablation.*

Conclusion: *RFCA had a high success rate. The complication rate was generally low and in the above-mentioned centers it was similar to those in other large centers worldwide. Echocardiography showed no difference before and after the ablation. The results from this study showed that the risk of permanent II or III-degree AV block in patients undergoing RFCA was low and deep vein thrombosis was the second important complication. There was no risk of life-threatening complications.*

J Teh Univ Heart Ctr 2 (2010) 87-91

Keywords: *Tachycardia, Atrioventricular nodal reentry • Catheter ablation • Electrophysiological techniques, Cardiac*

Introduction

During the last decade, radiofrequency catheter ablation (RFCA) has proved to be a successful method and the treatment of choice for supraventricular tachycardia. Since the introduction of this method, it has been modified and used for a variety of arrhythmias. The application and success rate of this treatment have been reported in many centers. One of the most frequent applications is for the treatment of atrioventricular nodal reentrant tachycardia (AVNRT), which is one of the most frequent causes of regular, paroxysmal supraventricular tachycardia. The RFCA of AVNRT has a

*Corresponding Author: ***Ahmad Yaminisharif,*** *Associate Professor of Cardiology, Tehran University of Medical Sciences, Tehran Heart Center, North Kargar Street, Tehran, Iran.1411713138. Tel: +98 21 88029257. Fax: +98 21 88029256. Email: yaminisharif.a@doctor.com.*

long-term success rate ≥ 95% and a low recurrence rate.[1-6]

In Iran, this method was initiated in 1994 with an increasing frequency in the following years. During a period of 14 years, we have experienced the RFCA of AVNRT in more than 500 patients. This study sought to evaluate the results of RFCA on AVNRT in two large hospitals, namely Shariati Hospital and Tehran Heart Center in Tehran, Iran and to evaluate the success rate during the fourteen years of experience.

Methods

The study patients comprised 544 consecutive patients who underwent the RFCA for AVNRT between March 1995 and February 2009. All the patients had a history of paroxysmal palpitation lasting between 1 and 25 years, and most of them had experienced unsuccessful treatment with different types of antiarrhythmic drugs.

Antiarrhythmic drugs were withheld for five half-lives prior to the ablation procedure. For the treatment of AVNRT, the electrophysiological study and ablation were conducted under local anesthesia. Intravenous heparin was administered with a bolus of 5000 units.

All the patients were ablated via the right-sided approach. In the early years, the five-catheter approach was used, including the placement of four diagnostic catheters (in the right ventricular apex, the His bundle area, the coronary sinus, and the high right atrium) plus one ablation catheter. Later, the three-catheter approach, including the placement of two diagnostic catheters and one ablation catheter, was applied. Meanwhile, a two-catheter approach using a single diagnostic electrode catheter placed in the high right atrium and one ablation catheter was utilized. Two-catheter approaches were not employed for a period of time and radiofrequency (RF) ablation was not continued with this method after 2 cases of atrioventricular (AV) block. Our first 7 years of practice in one hospital was without temperature-guided RFCA, and all the procedures in the second hospital were performed using temperature-guided catheters. Our electrophysiology study included atrial stimulation. Ventricular stimulation was preceded if AVNRT was not induced by atrial stimulation; and if sustained AVNRT (lasting ≥ 30 sec) was not induced by this protocol, isoproterenol (1μg/min) was administered until the basic sinus rhythm was increased by ≥ 20%, and the stimulation protocol was repeated.

After the confirmation of AVNRT, a standard 7F ablation catheter was introduced via the right femoral vein to the tricuspid annulus for RFCA. We used both anatomical and electrical approaches for ablation. The radiofrequency energy used in each approach was 25-40 W. RF energy was delivered with a temperature setting of 70°C using an initial power of 25 watts, which was gradually increased up to 40 watts if necessary. In patients who were treated without temperature-guided RF generator, the energy was 25 watts initially and gradually increased to 40 watts in a step-wise fashion. If an accelerated junctional rhythm was recognized within 30 seconds, the energy delivery was continued for a total of 1 minute. The administration of RF energy was discontinued upon the occurrence of AV block, very rapid junctional rhythm, retrograde block during junctional rhythm, impedance rise, catheter displacement, or severe chest pain.

The procedure was terminated if there was a significant PR prolongation of more than 50% of the baseline value during sinus rhythm. A successful ablation was defined as: if arrhythmia was no longer inducible with an intravenous infusion of isoproterenol and if no more than one atrioventricular reentrant beat occurred.

Dual AV node physiology was defined as ≥ 50 msec increment in atrium-to-His (AH) following a 10-msec decrement in coupling interval during single atrial extrastimulation or ≥ 50 msec increment in AH in consecutive beats after a 10-msec decrement in pacing cycle length during incremental atrial pacing. The ablation of the slow pathway was diagnosed when, after RF application, dual AV node physiology could no longer be demonstrated and neither AV nodal echoes nor AVNRT could be induced with and without isoproterenol infusion.

All the patients were observed in the hospital for at least 24 hours after successful ablation, with a daily 12-lead ECG recording. Echocardiography was performed for the patients before they were discharged.

The numerical variables were presented as mean ± standard deviation. The categorical variables were summarized in percentages. The probability values of $P < 0.05$ were considered statistically significant.

Results

The study population was comprised of 544 patients including 131 (24.1%) males and 413 (75.9%) females. The mean age of the patients was 48.89 ± 13.19 years (ranging from 9 to 85). Among them, 2.7% were ≤ 18 years old and 2.6% were ≥ 75. Underlying heart disease was present in 123 (23.2%) patients. The frequencies of the underlying heart diseases are listed in Table 1. It should be noted that 86.7% of the patients had no history of systemic disease.

More than 91.2% of the patients experienced treatment with different antiarrhythmic drugs, including 15.0% calcium channel blockers, 15.5% beta blockers, 4.2% Sotalol, and 1.1% digoxin. The rest of the patients had used a combination of different drugs during the period of their palpitation. The frequency of associated cardiac diseases in the study population prior to AVNRT ablation is shown in Table 1. Among these patients, the men had a greater incidence of associated valvular and ischemic heart diseases; except for mitral valve prolapse, which presented more frequently in the women. Almost all the approaches

were via the femoral vein; subclavian or internal jugular vein approaches were, however, used in some cases for coronary sinus (CS) mapping.

Table 1. Frequency of associated cardiac diseases in patients prior to AVNRT ablation

	Number	Frequency
Mitral valve prolapse	35	6.4%
Congenital heart disease	5	0.9%
Valvular heart disease	44	8%
Ischemic heart disease	34	6.1%
Hypertension	39	7.1%
Diabetes mellitus	23	4.2%
Congestive heart failure	1	0.2%
Hypertension & diabetes mellitus	10	1.8%

AVNRT, Atrioventricular nodal reentrant tachycardia

All the patients had sustained AVNRT induced with or without the administration of isoproterenol. All AVNRT arrhythmias were common type (slow-fast) except one pure uncommon AVNRT (fast-slow). A total of 36 patients had associated arrhythmias: atrial flutter in 22 (4%) patients, atrial fibrillation in 4 (0.7%), and concurrent atrial fibrillation and atrial flutter in 4 (0.7%). With the exception of atrial fibrillation, the other associated arrhythmias were also subjected to RFCA. A concomitant concealed atrioventricular pathway was identified in two (0.4%) patients; one of the pathways was located in the left lateral free wall and one located in the right posteroseptal wall.

A concomitant Wolff-Parkinson-White syndrome (WPW) was also found in four (0.7%) patients; three pathways were located in the right posteroseptal and one in left posterolateral wall.

The rate of successful ablation was 99.6%. The two-catheter approach was used in 80 (14.6%) procedures, while the multi-catheter approach was applied in the remaining 468 (85.4%). In 2 (0.4%) patients, the procedure failed in spite of a long procedural time.

There was no in-hospital complication in 519 (94.9%) of the procedures. Transient second- or third-degree AV block was observed in 21 (3.8%) patients, all of whom recovered within a few minutes. Two of the patients experienced II-degree AV block, which returned to normal conduction within a few days after the ablation; these two patients were ablated using a two-catheter approach. Permanent III-degree AV block occurred in 2 patients; both were older than 60 years and required the implantation of permanent pacemakers. Deep vein thrombosis developed in three (0.5%) patients early after the procedure; one of the patients was on oral contraceptive prior to ablation. There was no bleeding complication. Femoral arterio-venous fistula was observed in one (0.2%) patient. All the complicated patients were over 31 years old. Echocardiography was performed for all the patients before they were discharged. No change was observed in the echocardiography parameters after the ablation compared to the echo findings before the procedure, including grade of tricuspid regurgitation and presence of pericardial effusion.

Discussion

This study confirms that it is safe and feasible to perform RFCA for the treatment of AVNRT with a high success rate and a low complication rate. We observed a high success rate (99.6%) as well as low incidence of complications (2.9%) and need for permanent cardiac pacing (0.4%). None of the patients under 31 years of age was complicated. The risk of permanent AV block in patients who underwent slow pathway ablation in this study was low.

RFCA has been an available option for the management of supraventricular tachycardia since 1990 and is now the procedure of choice for the treatment of AVNRT. Several studies have reported the results of the RFCA of AVNRT. The results of the present study were similar to those from these reports including multicenter studies.[2-9]

The initial approach to the RFCA of AVNRT was the modification of the fast pathway of AV conduction by lesions placed near the anterosuperior aspect of the triangle of Koch.[10, 11] The results of this approach demonstrated longer PR intervals with longer AH intervals and longer antegrade Wenckebach cycle lengths and also significant risk of producing complete AV block necessitating permanent pacemaker implementation in as many as 15-20% of cases.[12]

Radiofrequency modification or ablation of the slow pathway, as an alternative technique, was developed to diminish these risks. This method has become the procedure of choice in AVNRT. After presenting the theory that the reentrant circuit in AVNRT may not be confined to the AV node but rather may incorporate the perinodal atrial myocardium,[10, 13] further studies localized the slow pathways fibers inferior toward the coronary sinus ostium.[14] The results of this approach have shown it to be extremely effective. In contrast to fast pathway modification, there is no significant change in the PR interval, the AH interval, or the AV Wenckebach cycle length in this technique.[13, 15, 16] More importantly, there is a lower rate of complications reported with this technique, including a lower risk of complete AV block as shown in several studies.

Despite anticoagulation, deep vein thrombosis developed in three (0.5%) patients early after the procedure in our institution (one with a history of oral contraception and the other two without any risk factor for systemic embolism). We did not observe bleeding complications such as cardiac tamponade, pericardial effusion, and significant hematoma. Recently published guidelines from the Committee of the

European Heart Rhythm Association[17] suggested that right-sided procedures (except atrial flutter) are at a low risk of thromboembolism during and after the procedure and the risk of bleeding seems to be higher with anticoagulation. This consensus document recommended that anticoagulation therapy is not necessary for right-sided procedures (during, and after the procedures) unless other risk factors for systemic embolism are present. In our experience, deep vein thrombosis was second serious complication after right-sided ablation even during anticoagulation.

As AVNRT is a definitive treatment by catheter-based RF energy delivery at the slow pathway area, it results in improved quality of life more than medications do.[18] Its advantages include relief of symptoms, improvement in functional capacity and the quality of life, elimination of the need for lifelong antiarrhythmic-drug therapy, and long-term cost savings.[19] In the present study, more than 91% of the patients experienced treatment by different antiarrhythmic drugs with no significant improvement in their condition.

Multiple venous sheath placements in the femoral veins are always required for multiple intracardiac catheter insertion. It has been reported[20] that multiple venous sheath (up to 3 sheaths) placements in a single femoral vein is acceptably safe in patients who have undergone EPS and RF ablation, even though non-occlusive deep vein thrombosis may develop in some patients. As we inserted more than two catheters in one femoral vein, it might have increased the tendency for developing deep vein thrombosis. The results of this study are limited to short-term follow-ups as long as 3 months; as a result, the recurrence rate and long-term results were not evaluated. Furthermore, the fact that this study was a retrospective one precluded a report on all the electrophysiological data of the patients.

Conclusion

RFCA had a high success rate. The in-hospital complication rate was generally low, and in the aforementioned centers it was similar to those in other large centers worldwide. The results of our echocardiography evaluations were similar before and after the ablation. The risk of permanent II or III-degree AV block in the patients undergoing RFCA was low. There was no risk of life-threatening complications. Deep vein thrombosis was the second important complication. Although there is a trend to mange the procedure without anticoagulation, the risk of deep vein thrombosis even after anticoagulation is still a challenging issue.

Acknowledgements

We would like to thank all the staff of the filing department in Tehran Heart Center and Shariati Hospital for providing a friendly working environment and their kind assistance in data gathering. This study was supported by Tehran University of Medical Sciences.

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