Long-Term Follow -Up After Radiofrequency Catheter Ablation of Fascicular Ventricular Tachycardia at National Institute of Cardiovascular Diseases

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Key words: *Radiofrequency Catheter ablation; Idiopathic left ventricle tachycardia.*

Abstract :

Introduction: *Verapamil-sensitive, idiopathic left ventricular tachycardia (ILVT) with right bundle branch block configuration and left-axis deviation is known to be due to re-entry mechanism but the exact nature of reentrant circuit in ILVT is not fully elucidated. In this study we evaluate the results of long-term clinical outcome in patients who underwent radiofrequency catheter ablation of idiopathic fascicular ventricular tachycardia in National Institute of Cardiovascular Diseases.*

Methods: *Electrophysiological studies and radiofrequency ablation were performed in 46 consecutive patients (42 men,04 women), age ranging from 16 to 36 years (mean 20±5 years) with verapamil-sensitive ILVT and structurally normal hearts. VT could be terminated by the intravenous administration of verapamil in all patients. Mapping was performed using a Bard electrophysiology system. The target site for ablation was the mid-septum of left ventricle where the earliest Purkinje potentials were recorded during VT. RF current was applied to the target site with or without late diastolic potential during VT in all patients to meet the ablation endpoints which were termination of the VT and non-inducibility of the tachycardia.*

Results: *All 46 patients had successful ablation of the ILVT. During 3 years follow up 02 patients had recurrence.*

Conclusion: *Idiopathic left ventricle tachycardia occurs most commonly in young population. Prompt recognition of this arrhythmia is important since radiofrequency ablation can cure this rhythm problem. This can be achieved in a country like Bangladesh where resources are limited.*

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Introduction :

The prognosis of patients with recurrent ventricular tachycardia depends on underlying heart disease. In general idiopathic VT originating from either left ventricle or right ventricle has a good prognosis[1-5].

Fascicular ventricular tachycardia is an idiopathic VT. It has unique electrocardiographic characteristics: right bundle branch block morphology and left axis deviation(Fig.1), occuring predominantly in young males. Fascicular tachycardia has been classified into three subtypes namely, left posterior fascicular VT, left anterior fascicular VT and upper septal fascicular VT [6-7].The mechanism of this tachycardia is believed to be localized reentry close to the fascicle of the left bundle branch. The reentrant circuit is composed of a verapamil sensitive zone[8-9].

Catheter ablation is the preferred choice of therapy in patients with fascicular VT. Ablation is carried out during tachycardia, using conventional mapping techniques in majority of the patients, while three dimensional mapping and sinus rhythm ablation is reserved for patients with nonmappable tachycardia[10-11.]

Patients and Methods

Patients

Between January 2005 and September 2008, we performed radiofrequency catheter ablation in 46 consecutive patients with idiopathic VT refractory to drugs. No structural heart disease was found by echocardiography in any of the patients. Cardiac catheterization and coronary angiography findings were normal in patients over 40 years of age. Left ventricular ejection fractions were determined by

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echocardiography. A 12-lead electrocardiogram of clinical VT was available for all patients. Clinical characteristics of 46 patients (42 men, 04 women) are summarized in Table 1. The mean (±SD) age of patients was 20±05 years (range, 16-36). In 45 patients, VT had a right bundle branch block with left axis deviation, and in 01 patients a right bundle branch block morphology with right axis deviation.. The mean cycle length of clinical VT was 328±22 ms (range, 280-360). Before ablation, all patients were treated by various antiarrhythmic drugs, including beta blockers (n=18), amidarone (n=16), sotalol (n=10), and calcium antagonists (n=2).

Electrophysiological Study

All patients gave their written informed consent to be included in electrophysiological study and undergo radiofrequency catheter ablation. Patients were kept fasting for at least 6 hours prior to the procedure. Antiarrhythmic drugs were discontinued for at least five half-lives of the drug. Peripheral intravenous access was obtained before the patient arrived at the EP laboratory. On arrival to the EP laboratory patient was placed on the fluoroscopy table and surface electrodes were attached for acquisition of 12 lead ECG through the electrophysiology recording system. Oxygen saturation was monitored continuously using pulse oximetry and blood pressure was monitored non-invasively every 5 minutes or more frequently in necessary. An external defibrillator was available in the room and in selected patients defibrillation pad was placed. Grounding pad for radiofrequency ablation was placed in the back once a decision for radiofrequency ablation was made. Procedure was performed under conscious sedation. Patient was prepped and draped using routine sterile technique prior to obtaining venous access. Four quadripolar electrode catheters were introduced percutaneously through the femoral veins and artery, and positioned in the right atrium, at the Hiss bundle area, right ventricular apex, and right ventricular outflow tract.After the ablation the catheters and sheaths were removed and hemostasis was achieved by manual compression. Patients were transferred to telemetry unit for monitoring. 12 lead ECG was performed next day and patients were discharged home.

Equipments

Recording system-A multi-channel data acquisition system manufactured by Bard Electrophysiology, C.R. Bard Inc, USA was used for data recording. The system consisted of an amplifier for acquiring and processing surface ECG and intracardiac signals, multi-channel display screens and a computer hard drive to store the ECG and intracardiac signals. The amplifier filtered the intracardiac signals between 30 and 500 Hz. The amplifier was connected to the patient via a junction box. The signals acquired by the amplifier were displayed on two monitors one of which was real time. For most studies 4 surface and 8 to 10 intracardiac signals were displayed simultaneously. However, the computer stored simultaneous 12 lead ECG and multiple intracardiac signals. The intracardiac signals could be viewed real time at speeds up to 200 mm/sec. In addition they could also be displayed later on for review. Selected segments of the recording could be printed in a laser printer.

Stimulator – A physiological cardiac stimulator manufactured by Micropace Ltd, Australia was used during the procedures. It is an electrically isolated unit is capable of delivering constant current pacing impulses. It is computerized and can be controlled from s keyboard. It is capable of simultaneous multiple chamber pacing and can deliver stimulus at different protocols such as rapid pacing, extrastimuli and burst pacing. The stimulation threshold was set at twice the measured diastolic threshold for each location.

Radiofrequency Ablation Generator: A radiofrequency ablation generator manufactured by Boston Scientific, USA, model EPT-1000 XP was used for ablation. This unit is capable of monitoring temperature, power and impedance during radiofrequency current application. It is capable of titrating the power automatically to maintain the desired temperature at the catheter tip. It was connected to intracardiac ablation catheter via a junction box and the radiofrequency current was delivered between the catheter tip and an external grounding pad placed on the back of the patient.

Programmed Electrical Stimulation

Programmed ventricular stimulation was performed at three cycle lengths (500, 400, and 350 ms), with 1-3 extrastimuli in two different sites of right ventricle(RV apex, and base or RVOT) at twice diastolic was used to induce VT. When sustained VT was not induced at the right

ventricular apex, stimulation protocol was repeated at the right ventricular outflow tract, with isoproterenol administered when necessary at infusionrate of 1-3 μg/min.

Radiofequency Catheter Ablation

After the baseline electrophysiological study, a quadripolar 7 French 4 mm deflectable standard catheter (EP Technology, Boston Scientific, USA)) with 2 mm interelectrode spacing was introduced in the left ventricle for ablation. The site of VT origin (ablation site) was determined by endocardial activation mapping and pace mapping. The mechanism for idiopathic left ventricular tachycardia is probably reentry, originating in the posterior Purkinje fiber network located in the apicoseptal portion of the left ventricle or midinferior septum . The target for ablation in idiopathic left ventricular tachycardia was often best defined as site with the earliest local electrogram and identification of an abnormal retrograde Purkinje potential (Fig, 4,5).

A radiofrequency ablation generator manufactured by Boston Scientific, USA, model EPT-1000 XP was used for temperature-guided radiofrequency ablation of the presumed site of VT origin. Actual power output, impedance, energy delivery, and catheter tip temperature were continuously monitored and displayed via an interface on a personal computer. Power output of 50 W was adjusted by use of the generator to reach and maintain the preselected temperature of 65oC for 60 seconds. In the area where VT terminated (Fig.6), RF current was applied for several times during sinus rhythm to elongate the lesion. Thirty minutes after ablation, the same VT induction protocol as at baseline examination was repeated. The procedure was considered successful if no sustained VT, nonsustained VT, or premature ventricular beats similar in configuration to clinical arrhythmia were induced or observed. After ablation, cardiac rhythm was monitored for 48 h, and control echocardiography was performed in all the patients.

Follow-up

All patients were checked up at our department every six months for medical history, physical examination, and 12-lead electrocardiogram.

Statistical Analysis

Data were expressed as mean±standard deviation, and the differences were assessed by Student's t-test. P values <0.05 were considered significant.

Results:

Electrophysiological studies and radiofrequency ablation were performed in 46 consecutive patients (42 men,04 women), age ranging from 16 to 36 years (mean 20±5 years) with verapamil-sensitive ILVT and structurally normal hearts.Clinical VT can be induced by programed ventricular stimulation, or by isoproterenol infusion in 43 of 46 patients (Table 3). No other clinical forms of VT were provoked in any of the patients. Clinical characteristics of 46 patients (42 men, 04 women) are summarized in Table 1. Radiofrequency catheter ablation was successful in all 46 patients after delivering 6±2 (range, 2-9) radiofrequency pulses(Table 5). VT originating in the left ventricle had an mid posteroseptal site in 44 patients and an inferoposterior septal site in two patients. All patients, Purkinje potential was recorded preceding the beginning of the QRS of VT (Fig. 4,5). All these patients were successfully ablated after delivery of radiofrequency pulses. At the time of VT elimination, the mean catheter tip temperature measured 62±6°C (range, 60-64.There were no immediate complications of ablative procedure in any of the patients, irrespective of the site of VT origins. Before the ablation, the mean left ventricular ejection fraction was 64±5% (range, 57-70%). During the mean follow-up period of 03 years, none of the patients developed ventricular dysfunction or new form of VT as a consequence of ablation. The recurrence of clinical VT was observed in 2 patients.

Table-I

Baseline characteristics of patients (n-46)

Patient Characteristics	No. (%)
Male	42
Female	04
Age range	16 - 36
Average age (years)	(mean 20± 05 years)
LVEF (%)	68± 01
Diabetes mellitus	02(4.3%)
Hypertension	01(2.17%)
Bronchial asthma	03(6.5%)

Table-II
Types of Fascicular Tachycardia (n-46)

Ventricular tachycardia	Number (%)
Left posterior fascicular	44 (95.65)
Left anterior fascicular	02 (04.35)

Table-III
Tachycardia Inducibility at EP Lab

Rhythm	Number (%)
Sustained VT	40(86.96)
Non sustained VT	03(06.52)
Non-inducibility	03(06.52)

Table-IV
Radiofrequency Ablation Target Site (n-46)

Rhythm	Target Site	End Point
Fascicular Tachycardia (n-40)	Perkinjee potential	VT termination and non-inducibility
Sinus rhythm(n-06)	Perkijee potential	Non-inducibility

Table-V
Results and Follow-up(n-46)

Outcome	Number (%)
Acute success	46(100%)
Recurrence	02(4.35)
Major complications	00 (00)

Fig.-1: *ECG of Left posterior fascicular VT showing RBBB morphology with left axis deviation*

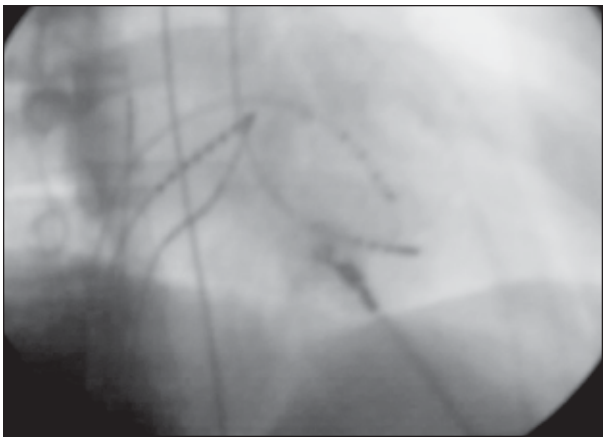

Fig.-2: *Position ablation catheter at successful ablation site in RAO 35^0*

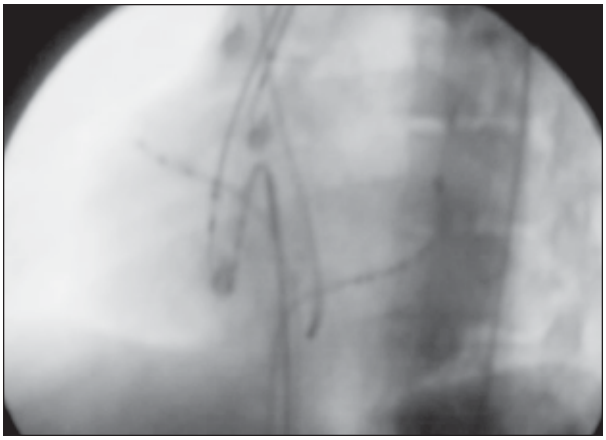

Fig.-3: *Position ablation catheter at successful ablation site in LAO 45^0*

Fig.-4: *Electrogram of Fascicular VT showing Purkinje potential in ABL 1-2 catheter at successful ablation site. The purkinje potential preceded the surface QRS by 36 msec*

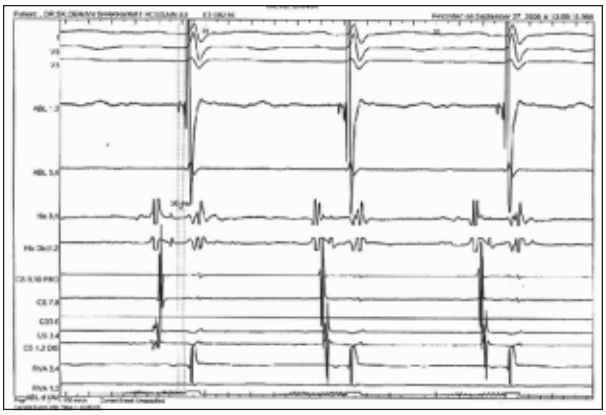

Fig.-5: *Electrogram of Fascicular VT at sinus rhythm showing Purkinje potential in ABL 1-2 catheter at successful ablation site. The purkinje potential preceded the surface QRS.*

Fig.-6. *Electrogram of fascicular VT showing termination of VT to sinus rhythm following application RF energy.*

Discussion

The first report of fascicular ventricular tachycardia was in 1979 by Zipes et all; they described a ventricular tachycardia (VT) of right bundle branch block morphology with left axis deviation and a relatively narrow QRS width (Fig 01) [10]. At present this tachycardia is well characterized as one presenting as exercise related VT in the age group of 15 to 40 years and predominantly in males (60% to 80%)[10]. Fascicular VT occurs in patients with no structural cardiac abnormality and is usually paroxysmal, but it can occasionally be incessant in nature resulting in tachycardiomyopathy. While termination by calcium channel blockers is the hallmark of this tachycardia, catheter ablation is very effective in the cure of this tachycardia [11-12]. Intravenous verapamil is effective in terminating the tachycardia. However the efficacy of oral verapamil in preventing tachycardia relapse is variable. Though fascicular tachycardias do not generally respond to adenosine, termination of VT originating from the left anterior fascicle by intravenous adenosine has been documented. Different approaches for radiofrequency ablation have been described by various authors. Nakagawa et al preferred careful localization of the Purkinje potential in guiding ablation[13]. They selected the area where a Purkinje potential precedes the QRS complex during tachycardia. Nogami et al. recommend pace mapping with a match between the 12 simultaneously recorded ECG leads during pacing and the clinical tachycardia for localizing the site of ablation[14]. They hypothesize that pathways within the Purkinje network that are not included in the reentry circuit responsible for the tachycardia may also become activated. Ablation of those regions may not result in interruption of the tachycardia circuit. Since fascicular VT is sometimes difficult to induce despite pharmacological provocation, some workers prefer primary ablation. In a recent report, seven cases of incessant fascicular VT were successfully ablated with no recurrence. They reported a shorter procedure time, significantly lower fluoroscopy time and lesser number of radiofrequency energy deliveries in the primary versus elective groups. The longer procedural time during elective ablation was mainly due to the time spent in induction of fascicular VT[15]. Results of our study is similar to other studies described above. Recurrence rate is lower than that described in other studies.

Study Limitations

This is an observational, nonrandomized trial reporting the efficacy of RF ablation in patients with drug refractory ILVT. Furthermore, the antiarrhythmic drug regimen was nonuniform but reflects routine daily practice. Although all inducible VTs were targeted, this study was limited to patients who tolerated tachycardia for a prolonged period. Although the outcome of this study with routine clinical practice, it is important to note that RFCA procedures in patients with drug refractory VT are complex ,time consuming, and uncomfortable for patients.

Conclusion

Idiopathic left ventricle tachycardia occurs most commonly in young population. It is a unique

clinical entity, characterized by RBBB and left/ superior axis morphology without structurally heart disease. Prompt recognition of this arrhythmia is important since specific treatment will terminate the VT. Prognosis is excellent, with high cure rate after radiofrequency catheter ablation

References

1. Zipes DP, Foster PR, Troup PJ, et al. Atrial induction of ventricular tachycardia: reentry versus triggered automaticity. *Am J Cardiol*. 1979; 44:1 8.
2. Belhassen B, Rotmensch HH, Laniado S. Response of recurrent sustained ventricular Tachycardia to verapamil. *Br Heart J*. 1981;46: 679 82.
3. Bennett DH. Experience with radiofrequency catheter ablation of fascicular tachycardia. *Heart* 1997;77:104 107.
4. Thakur RK, Klein GJ, Sivaram CA, et al. Anatomic substrate for idiopathic left ventricular tachycardia. *Circulation*. 1996; 93:497 501.
5. Lin FC, Wen MS, Wang CC, et al. Left ventricular fibromuscular band is not a specific substrate for idiopathic left ventricular tachycardia. *Circulation*. 1996;93:525 8.
6. Ouyang F, Cappato R, Ernst S, et al. Electroanatomic Substrate of Idiopathic Left Ventricular Tachycardia: Unidirectional Block and Macroreentry Within the Purkinje Network. *Circulation* 2002; 105:462 469.
7. Nogami A. Idiopathic left ventricular tachycardia: assessment and treatment. *Card Electrophysiol Rev*. 2002; 6: 448 57.
8. Shimoike E, Ueda N, Maruyama T, et al. Radiofrequency catheter ablation of upper septal idiopathic left ventricular tachycardia exhibiting left bundle branch block morphology. *Journal of Cardiovascular Electrophysiology* 2000; 11: 203 207.
9. Ohe T, Shimomura K, Aihara N, et al. Idiopathic sustained left ventricular tachycardia: clinical and electrophysiologic characteristics *Circulation* 1988; 77: 560-568.
10. Lin D, Hsia HH, Gerstenfeld EP, et al. Idiopathic fascicular left ventricular tachycardia: linear ablation lesion strategy for noninducible or nonsustained tachycardia. *Heart Rhythm*. 2005; 2:934 939.
11. Ma Fu sheng, Ma Jian, Kai T, et al. Left posterior fascicular block: a new endpoint of ablation for verapamil sensitive idiopathic ventricular tachycardia. *Chin Med J* 2006; 119:367 372.
12. Magalhaes S, Goncalves H, Primo J, et al. Fascicular ventricular tachycardia: experience with radiofrequency ablation. *Rev Port Cardiol*. 2006;25:485 97.
13. Nakagawa H, Beckman KJ, McClelland JH, et al. Radiofrequency catheter ablation of idiopathic left ventricular tachycardia guided by Purkinje potential. *Circulation* 1993;88:2607-17.
14. Nogami A, Naito S, Tada H, et al. Demonstration of diastolic and presystolic purkinje potentials as critical potentials in a macroreentry circuit of verapamil sensitive idiopathic left ventricular tachycardia *J. Am. Coll. Cardiol.* 2000; 36; 811 82 3).
15. Aiba T, Suyama K, Aihara N, et al. The Role of Purkinje and Pre Purkinje Potentials in the Reentrant Circuit of Verapamil Sensitive Idiopathic LV Tachycardia. *PACE* 2001;24:333 344.