Idiopathic Fascicular Left Ventricular Tachycardia: Case Report and Review of the Literature

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ABSTRACT. Left ventricular tachycardia is often considered a life-threatening arrhythmia. Idiopathic fascicular left ventricular tachycardia (ILVT) accounts for 10–15% of all left ventricular tachycardias. We present a typical case of ILVT in a young 34-year-old gentleman presenting with a wide-complex right bundle, left superior axis tachycardia. We follow with a discussion of proposed electrophysiologic mechanisms by which ILVT exists as well as treatment modalities. Recent advances in mapping and ablation techniques have rendered this an increasingly curable condition with a high success rate.

KEYWORDS. calcium sensitive, CARTO mapping, cryoablation, idiopathic left ventricular tachycardia, left axis, posterior fascicle, posterior fascicular ventricular tachycardia, right bundle, verapamil sensitive.

Introduction

Idiopathic fascicular left ventricular tachycardia (ILVT) represents 10–15% of all idiopathic left ventricular tachycardia seen in clinical practice today. This arrhythmia was first described by Zipes et al. in 1979, when they reported three cases of right bundle branch block (RBBB) left axis ventricular tachycardia (VT) with a relatively narrow QRS (120–140 ms) in young patients. In 1981, Belhassen et al. demonstrated that intravenous administration of verapamil significantly decreased the recurrence rate of ILVT in afflicted patients. In this paper, we present a case of ILVT followed by a review of patient characteristics, possible mechanisms, electrophysiologic properties, and management options.

History

A 34-year-old man with a history of palpitations presented to the emergency department with a 3-day history of severe constant pressure-like substernal chest pain which was associated with shortness of breath and dizziness. He stated that the symptoms initially began after exertion and did not abate. On examination, the patient was noted to be tachycardic in the 170s with a normal blood pressure and physical examination. The electrocardiogram (ECG) revealed a wide-complex tachycardia at a rate of 170 bpm with a RBBB pattern and left superior axis deviation (Figure 1). The patient was initially treated with successive rounds of adenosine, which were ineffective. Intravenous amiodarone successfully slowed the tachycardia but did not terminate it. Finally, the patient received intravenous diltiazem, which terminated the tachycardia with resultant normal sinus rhythm.

Hospital course

The patient was admitted to a cardiac telemetry unit and initiated on oral diltiazem. His hospitalization was uneventful and he was subsequently discharged home with the plan to return for a radiofrequency ablation. The patient returned for an elective ablation within a month with no recurring events in the interim. During his electrophysiology study, we were able to induce a nonsustained right bundle, left superior axis VT which electrocardiographically matched his original VT, suggesting an
Although the VT was not sustained long enough for precise activation mapping, given the clinical presentation, typical morphology, and response to diltiazem, an empiric ablation transecting the left posterior fascicle along the left ventricular septum was successfully performed. During post-ablation testing, we were no longer able to induce the VT.

Discussion

ILVT typically affects young males aged 15–40 years, who account for 60–80% of all cases. Symptoms typically include dizziness, palpitations, chest discomfort, and occasionally syncope. Patients will often present with paroxysms of VT making it difficult to diagnose and capture; although sustained VT does occur. Most episodes occur at rest, though VT can also be triggered during elevated states of catecholamine such as exercise or emotional stress.

Posterior fascicular VT by far accounts for the majority of ILVT, representing over 90% of cases. Often, ILVT is mistaken for supraventricular tachycardia with aberrancy. The surface electrocardiogram demonstrates tachycardia with a RBBB pattern and a left superior axis deviation. Other forms of ILVT include anterior fascicular VT presenting with a RBBB and right axis deviation as well as the more rare upper septal fascicular VT which can present with either a RBBB, left bundle branch block (LBBB), or a normal QRS.

Anatomically, it is believed that the re-entrant loop for posterior fascicular VT involves a verapamil-sensitive septal myocardium that exhibits decremental properties from the base to the apex of the LV. Nogami et al. elegantly demonstrated the presence of a mid-diastolic pre-Purkinje potential (P1) and a pre-systolic potential (P2) (Figure 3). P1 is described as a low frequency mid-diastolic potential during VT whereas P2 is described as a sharp, short-duration, high-frequency presystolic potential. The septal myocardium serves as the antegrade limb for the VT and is responsible for the creation of P1 during VT. The retrograde limb consists of either the posterior fascicle or its nearby tissue creating P2 during VT. It has traditionally been thought that P2 was created by a retrograde limb formed by the posterior fascicle. However, other studies have challenged this idea. Morishima et al. have suggested that P2 may actually represent activation of the myocardial tissue in proximity to the fascicle. Kuo et al. demonstrated that ablation of ILVT did not result in fascicular block, leading the authors to conclude that the fascicle may not be involved in the re-entry circuit, simply the tissue adjacent to it. It has still not been completely elucidated whether the circuit is completely defined by fascicular tissue alone or whether there is a component of ventricular myocardium involved.

Therapeutic options

Belhassen and Rotmensch’s paper demonstrating the effectiveness of verapamil in suppressing this form of ILVT suggests a role for the slow inward calcium current, although a definitive cellular mechanism of the effect has not been described. The verapamil sensitivity of the antegrade limb has been demonstrated by noting a significant increase in the His–P1 interval after administration.
of IV verapamil during sinus rhythm. In later studies, verapamil was noted to significantly prolong P1–P2 and P2–P1 intervals. Both verapamil and diltiazem have been reported to be effective in terminating the tachycardia. Although intravenous administration is very effective, oral administration tends to exhibit variable success in the long-term suppression of ILVT. β-Blockers and adenosine have also been reported as variably effective.

Radiofrequency (RF) ablation, conferring a cure rate of over 90%, has become the preferred first-line treatment option for patients with ILVT. Cryotherapy has also been successfully used to treat this arrhythmia and has multiple advantages including the ability to cryomap ablation targets as well as the lack of pain during ablation. Although only a small population of patients have been studied using cryoablation to treat idiopathic left ventricular tachycardia, it shows promise as a potential modality of treatment.

Ablation during ventricular tachycardia

Ablation during ventricular tachycardia offers several advantages. Successful VT initiation often is achieved with premature atrial and/or ventricular stimulation with or without isoproterenol infusion. Entrainment mapping can then be utilized to identify and confirm the circuit as well as determine potential targets for ablation. Finally, ablation success is readily determined with tachycardia termination and inability to reinduce.

Ablations have been performed successfully using different techniques to target the retrograde limb or the anterograde limb. Nakagawa et al. reported success by ablating the earliest presystolic Purkinje potential (P2) in the retrograde limb, which is within the distal third of the left ventricular inferior septum. Pacing from this site often reveals concealed entrainment with a post-pacing interval equal to the tachycardia cycle length. In contrast, Nogami et al. investigated ablating in the anterograde limb. The majority of patients had successful ablation with initial energy delivery when P1 and P2 were both identified in the midseptum and the interval between P1 and the surface QRS complex was $60 \pm 29$ ms. They demonstrated that targeting P1 in the mid- to apical third of the septum would successfully terminate VT without risking complete LBBB or complete heart block. Abating

Figure 2: Intracardiac electrogram of tachycardia during electrophysiology study. Note that there is clear atrioventricular (AV) dissociation and that the tachycardia exhibits the same RBBB, left superior axis deviation as the clinical arrhythmia.
more proximally carries the theoretical risk of complete heart block or complete LBBB due to proximity to the His bundle and left bundle branch common trunk.

Ablation during sinus rhythm

ILVT ablation during sinus rhythm may be considered in cases where the VT is non-inducible, non-sustained, or hemodynamics preclude mapping during VT. Pace-mapping from the inferior septum has been attempted with variable success since pace-mapped exits may differ during sinus rhythm resulting in a less than 12/12 match to the clinical VT despite the site being integral to the circuit. Alternatively, an empiric ablation transecting the apical third of the left ventricular posteroseptum may be placed extending from the mid-inferior septum to the inferior free wall. Moreover, a three-dimensional mapping system may be used to delineate the left posterior fascicle as well as an area of slow conduction by mapping out P1 potentials during sinus rhythm. Since these potentials are short, sharp, and high frequency, they are easily identified with electroanatomic mapping. Chu et al. demonstrated that the conduction velocity at the origin or

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**Figure 3:** Highlighted are the pre-Purkinje potential (pre-PP or P1) and Purkinje potential (PP or P2). The proposed antegrade circuit travels in the myocardial septum creating P1. The turnaround point occurs in the apical third of the left ventricle resulting in P2 as the impulse travels retrograde. Adapted with permission from Dr. Calambur Narasimham.
these potentials is slower than in the myocardium and concluded that this represented the beginning of the slow conduction zone. Serially recorded potentials were followed out until P1 and P2 were both recorded simultaneously likely reflecting the exit of the slow conduction zone. Ablation at the junction where both P1 and P2 potentials are evident often results in successful ablation and is one technique that can be utilized during sinus rhythm and ventricular tachycardia.\textsuperscript{12,13}

**Conclusion**

ILVT continues to represent a common form of left ventricular tachycardia in patients with seemingly structurally normal hearts. Medical management is variable in its outcomes and given the age of the population affected, it is often difficult to ensure adherence. Ablation has a high success rate with minimal complications and excellent longevity. Ablation during ventricular tachycardia and sinus rhythm has been performed successfully with or without the use of three-dimensional anatomic mapping. ILVT should always be considered in the differential for patients presenting with a regular right bundle branch tachycardia. With the current knowledge concerning the pathophysiology of the tachycardia and modern ablation techniques, ILVT now has an excellent prognosis.

**References**