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CASE REPORT

CLINICAL CASE

Infra-Hisian Conduction Disturbance and Alternating Left Anterior/Posterior Fascicular Block

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ABSTRACT

We present an unusual case of alternating left anterior and left posterior fascicular block. Given the known risk for progression to complete atrioventricular block with alternating right bundle and left bundle branch block, we performed an electrophysiological study. Findings were consistent with infra-Hisian disease, and the patient underwent pacemaker implantation. (J Am Coll Cardiol Case Rep 2024;29:102363) © 2024 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Alternating right bundle branch block (RBBB) and left bundle branch block (LBBB) and its association with a high risk for progression to complete atrioventricular (AV) block is a well-known phenomenon. However, cases of alternating left anterior fascicular block (LAFB) and left posterior fascicular block (LPFB) are surprisingly uncommon.

LEARNING OBJECTIVES

- To identify patients at high risk for infra-Hisian conduction disease and implement the necessary work-up to determine the need for pacemaker implantation.
- To recognize the utility of an EP study with pharmacologic maneuvers in the diagnosis of conduction system disease.
- To understand the pathophysiology of infra-Hisian conduction system disease.

The lack of guidelines regarding management options for these patients poses a clinical challenge, even for the experienced electrophysiologist. The phenomenon of alternating LAFB and LPFB was first reported by Rosenbaum et al[1] in a textbook published in 1967 titled *Los Hemibloqueos*. Since then, only a handful of cases have been described in the literature. We report a case of alternating LAFB and LPFB in a patient with existing RBBB presenting to our emergency department reporting chest discomfort.

HISTORY OF PRESENTATION

An 81-year-old man presented to our emergency department with a chief symptom of chest pain. The patient reported nonexertional intermittent chest discomfort starting 2 days prior to presentation. There was no report of a syncopal event, lightheadedness, or palpitations.

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ABBREVIATIONS AND ACRONYMS

AV = atrioventricular

EP = electrophysiological

H-V = His-ventricular

LAFB = left anterior fascicular block

LBBB = left bundle branch block

LPFB = left posterior fascicular block

RBBB = right bundle branch block

PAST MEDICAL HISTORY

The patient's medical history included single-vessel coronary artery disease, type 2 diabetes, hyperlipidemia, and chronic kidney disease.

DIFFERENTIAL DIAGNOSIS

Two years prior to presentation, left heart catheterization revealed 40% left anterior descending artery stenosis. The patient's first electrocardiogram in the emergency department demonstrated normal sinus rhythm with RBBB, in addition to a left-axis deviation and qR pattern in lead aVL consistent with LAFB (Figure 1A). High-sensitivity troponin levels were not indicative of ischemia, and the patient remained chest pain free throughout his admission. Upon arrival to the cardiology unit, the patient underwent repeat electrocardiography, showing normal sinus rhythm, RBBB, and a right-axis deviation with an rS pattern in leads I and aVL, consistent with LPFB (Figure 1B).

INVESTIGATIONS

The patient underwent pharmacologic stress testing given severe neuropathy and inability to exercise on the treadmill, in addition to transthoracic echocardiography. Both tests revealed no evidence of ischemia or structural heart disease.

On the basis of concern for alternating bundle branch block patterns, and after review of the limited literature on such unusual cases, the patient underwent invasive electrophysiological (EP) study. Consent was also obtained for either dual-chamber pacemaker placement in case of infra-Hisian conduction system disease or loop recorder implantation if no abnormality was found.

A standard 3-catheter EP study was performed. In the baseline state, the atrial-His interval was 97 ms and the His-ventricular (H-V) interval was 60 ms, slightly longer than the standard upper normal limit of 55 ms. The AV node effective refractory period was 380 ms, and Wenckebach cycle length was 470 ms. Given normal physiology during the EP study and incremental atrial pacing, further diagnostic strategies were pursued, including atropine and procainamide medication challenges. Following the administration of 0.5 mg atropine, the H-V interval remained unchanged. Procainamide was then infused at a rate of 10 mg/kg over 20 minutes, and the H-V interval increased significantly from 60 to 99 ms, along with spontaneous infra-Hisian block (Figure 2).

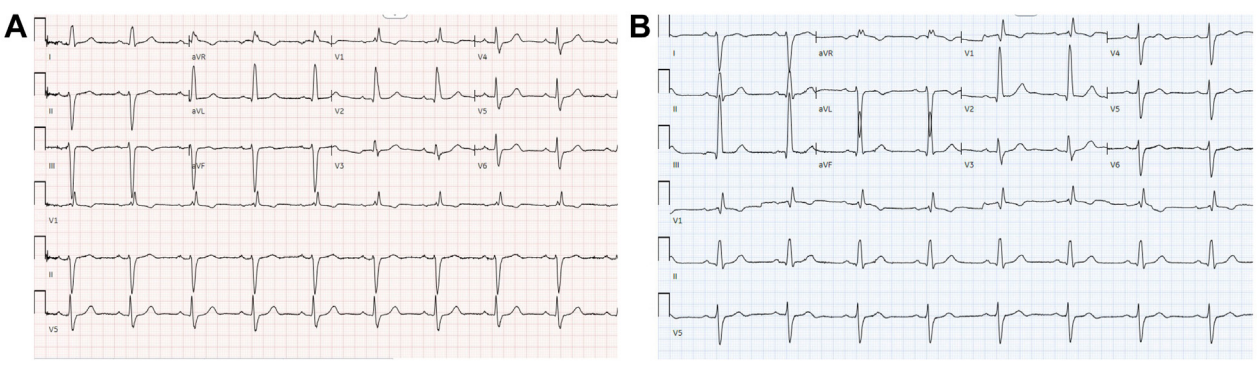
MANAGEMENT

As the H-V interval was essentially at the 100-ms cutoff known to predict progression to high-grade AV block as well as infra-Hisian block, we proceeded with dual-chamber pacemaker implantation.[2] There was no complication following the procedure, and the patient is followed via remote monitoring at our institution.

DISCUSSION

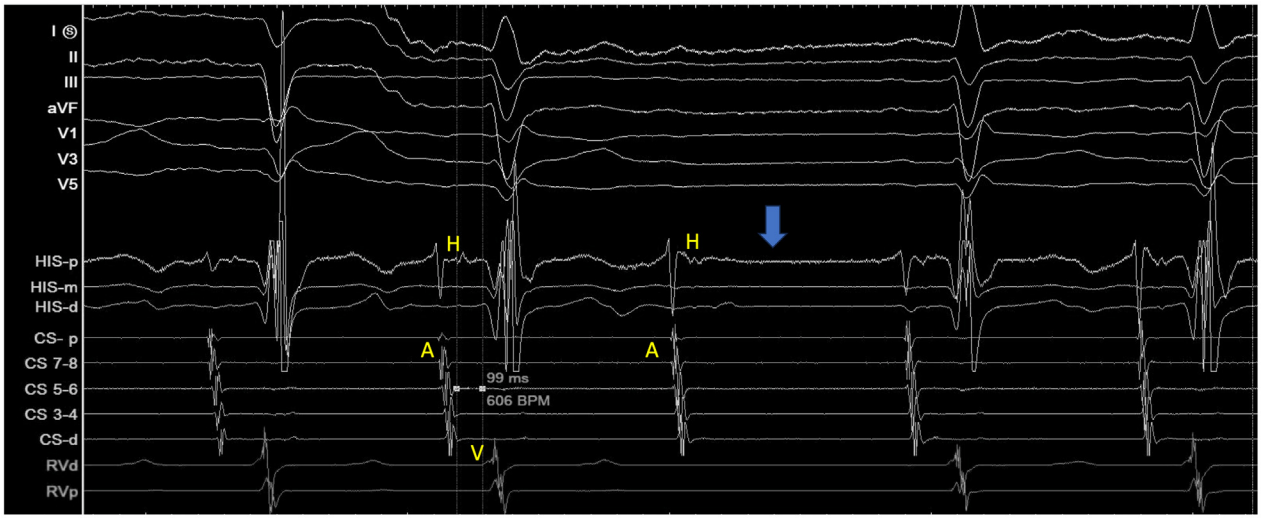
We report an unusual case of a patient with alternating LAFB and LPFB and a fixed RBBB who underwent EP study and was diagnosed with infra-Hisian conduction system disease during procainamide challenge. As the patient presented to our institution

FIGURE 1 Electrocardiography



(A) The electrocardiogram at presentation demonstrates sinus rhythm with right bundle branch block and left anterior fascicular block. (B) The follow-up electrocardiogram reveals sinus rhythm with right bundle branch block and left posterior fascicular block.

FIGURE 2 **Intracardiac Electrograms During Procainamide Infusion**



Intracardiac electrograms demonstrate a prolonged His-ventricular (H-V) interval (99 ms), followed by a dropped ventricular signal after a His bundle signal (blue arrow), diagnostic of infra-Hisian block. A = atrial signal.

with chest discomfort, serial electrocardiography was performed as part of a standard ischemic work-up and unmasked concerns for conduction system disease.

It is well established in current guidelines that true alternating RBBB and LBBB warrants permanent pacing.[3] The overall incidence of progression to complete heart block in these patients is 1% to 2% per year.[4] In patients presenting with syncope and alternating RBBB and LBBB, the incidence rises to 17% over 5 years.[4] Similarly, a patient with bundle branch block presenting with syncope and found to have an H-V interval of 70 ms or greater during EP study should also undergo permanent pacemaker implantation.[3] If the H-V interval reaches 100 ms, the risk for progression to high-grade AV block may be as high as 70% within 2 years.[5] However, alternating LAFB and LPFB is an uncommon finding, and the necessary diagnostic testing is unclear to determine the need for permanent pacing. A literature search reveals only 3 cases of this phenomenon since it was first described by Rosenbaum et al[1] in 1967.[6-8] EP hypotheses offered in some of the literature refer to impaired conduction and differences in refractoriness in both fascicles. This phenomenon is often accompanied by a prolonged PR interval, which can allow recovery of 1 of the fascicles.[5]

Our patient's presentation raised several questions regarding the evolution of patients with alternating LAFB and LPFB in the presence of RBBB. Many electrocardiographic properties are known to assist in the localization of conduction block, including the width of the QRS complex, PR interval length, and the effect of exercise. The observation of a wide QRS complex, which is often associated with infra-Hisian disease process, is not reliable. Similarly, the PR interval may be normal even in the presence of severe infranodal disease. Exercise stress testing then becomes a useful diagnostic tool, as AV nodal conduction is expected to improve with an increase in sympathetic drive. If conduction block worsens with exercise, infranodal disease is suspected, and permanent pacing is often required. Unfortunately, because our patient was unable to exercise given severe neuropathy and given ongoing concern for infra-Hisian disease, we proceeded with an EP study.

In the baseline state, the patient's H-V interval was 60 ms, only 5 ms longer than the 55-ms cutoff. However, to unmask or rule out His-Purkinje system disease during EP study, incremental atrial pacing and pharmacologic challenges should be performed when the baseline H-V interval is within normal limits.[4] Indeed, the risk for progression to high-grade AV block is approximately 30% within 3 years if infra-Hisian block is noted at atrial pacing rates up to 150 beats/min.[3] Our patient did not develop infra-Hisian block during atrial pacing, and therefore atropine was administered as the next step. Atropine is comparable with exercise, as it should result in improved

conduction through the AV node and worsening conduction in the presence of infra-Hisian disease.[8] The H-V measurement again remained stable, and procainamide was administered as our last diagnostic tool. In individuals with normal conduction systems, procainamide increases the H-V interval by approximately 10% to 20%.[9] However, in patients with conduction system disease, Josephson[10] reported 3 main findings that raise the likelihood of spontaneous infra-Hisian block during procainamide infusion: doubling of the H-V interval, an H-V interval >100 ms, and spontaneous second- or third-degree infra-Hisian block. As our patient had 2 of these findings, there were enough diagnostic clues to proceed with pacemaker implantation.

FOLLOW-UP

For the first 6 months following implantation, remote interrogation revealed 88% pacing percentage in the atrium and <0.1% in the ventricle.

CONCLUSIONS

Alternating LAFB and LPFB is a rare presentation of infra-Hisian conduction system pathology that may require an invasive work-up. Our case is a reminder of the importance of thorough surface 12-lead electrocardiographic review, especially when patients present with a chief symptom seemingly unrelated to conduction system disease. Several diagnostic tools exist and have been described in the literature to further localize the level of block and properly assess the H-V interval to determine the need for permanent pacing. In this case, making the correct diagnosis required in-depth knowledge of these strategies, including incremental atrial pacing and procainamide challenge during EP study. Given the lack of guidelines regarding the management of alternating LAFB and LPFB, we must rely on unique situations such as this case to improve our knowledge of a rare yet possibly life-threatening conduction system disturbance.

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