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New Onset LBBB with ST Elevation After Minimally Invasive Aortic Valve Replacement: Differential Diagnosis

--Manuscript Draft--

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April 30, 2022

To the Editor

Annals of Emergency Medicine

Re: New onset LBBB with ST elevation after minimally invasive aortic valve replacement: Differential Diagnosis.

Enclosed please find our case presentation, entitled “**New onset LBBB with ST elevation after minimally invasive aortic valve replacement: Differential Diagnosis.**”, submitted for consideration for publication in *the section of ECG of the month*.

The manuscript, or part of it, has neither been published nor is currently under consideration for publication by any other journal.

All three co-authors have participated in the study and read the manuscript and approved its submission to European Heart Journal.

Thank you

Sincerely,

Yochai Birnbaum, MD



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A few more requested:

1. Please remove the sentence in the 1st paragraph which is duplicated in the discussion - "There are prominent J-points with minimal ST elevation in the inferior leads + V5-V6 compatible with mild early repolarization."

Done

2. Separate the first paragraph of the discussion and title it "description of EKG findings" per format requirements.

Done

Update Teaching points:

3. Please correct and clarify the teaching point. "New LBBB in isolation, even if associated with concordant ST elevation should not be automatically considered a sign of ST elevation AMI." If new LBBB is in isolation, then by definition, it does not have concordant STE.

New LBBB in isolation is not predictive of AMI.

LBBB with concordant ST elevation should be considered due to occlusion MI but occasionally may be associated with other conditions such as pericarditis.

Done

4. The current Figure 1 should be split since that will appear on the first page - the EKG itself should be Figure 1. The annotated blowups should be Figure 2.

Done

5. The current Figure 2 is potentially confusing. It appears in the text you are favoring it to represent early repolarization since it is unchanged from the past EKG prior to surgery. Since LBBB is no longer present, consider eliminating this image and just report that the follow up at 10 days is similar to the past EKG before surgery and therefore favored to represent early repolarization.

Eliminated and replaced with the previous Figure 1b.

New onset LBBB with ST elevation after minimally invasive aortic valve replacement: Differential Diagnosis.

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New onset LBBB with ST elevation after minimally invasive aortic valve replacement: Differential Diagnosis

A 64-year-old male with severe aortic stenosis underwent minimally invasive aortic valve replacement. Coronary angiography prior to surgery revealed non-obstructive coronary artery disease. His electrocardiogram (ECG) prior to surgery showed sinus rhythm with voltage criteria for left ventricular hypertrophy (LVH). Postoperatively he developed right pleural effusion, drained with a pigtail catheter. Computerized tomography image of the chest did not show pericardial effusion. Three days after surgery he developed atrial flutter with 4:1 conduction and Right Bundle Branch block that converted to sinus rhythm with intravenous amiodarone. On day 5 after surgery, he developed shortness of breath associated with hypotension. ECG is shown in Figure 1.

What is the diagnosis:

1. This is acute coronary occlusion myocardial infarction (ACOMI), as he developed new left bundle branch block (LBBB)
2. This is ACOMI, as he has concordant ST elevation (STE) in the inferolateral leads in a setting of LBBB
3. The ECG changes were caused by the amiodarone infusion
4. This is pericarditis
5. This is early repolarization
6. Nonspecific ECG changes following heart surgery
7. Further workup is needed to make the diagnosis

Discussion

Description of the ECG findings:

The ECG before surgery showed sinus rhythm with voltage criteria for LVH. There were prominent J-points with minimal STE in the inferior leads +V5-V6, as well as J-point elevation in V2-V4, compatible with normal variant early repolarization. Figure 1 shows sinus rhythm with first degree AV block. There is PR segment depression in II, aVF, V3-V6. There is new onset LBBB (QRS duration of 148msec). There is concordant STE in I, II, III, aVF, V4-V6 (Figure 2).

In a patient who is hypotensive after aortic valve replacement the differential diagnosis is extensive and includes bleeding, hypovolemia, valve malfunction, ischemia, pericardial effusion with tamponade, and aortic dissection. ECG and bedside transthoracic echocardiogram to rule out pericardial effusion, regional wall motion abnormalities and dissection flap in the aortic root should be ordered; however, the accuracy of echocardiogram to detect regional wall motion abnormalities in patients with LBBB presenting with AMI is low due to desynchrony and presence of previous wall motion abnormalities."

The 2013 American College of Cardiology Foundation/American Heart Association Guideline for the Management of STEMI states: "New or presumably new LBBB at presentation occurs infrequently, may interfere with STE analysis, and should not be considered diagnostic of acute myocardial infarction (AMI) in isolation" ¹. It is commonly believed that ST deviation post cardiac surgery is not specific. However, occasionally it does reflect pathology, including pericarditis and AMI ². Concordant STE is according to

Sgarbossa et al a specific sign of acute myocardial infarction in patients with LBBB³. Thus, similar ECG in a patient with compatible symptoms should suggest ST elevation myocardial infarction. While the coronary angiogram prior to surgery showed no significant coronary artery disease, AMI due to iatrogenic dissection of the coronary arteries or aorta after surgery⁴ or coronary embolus cannot be ruled out. Diffuse concordant ST deviation in a patient with LBBB may also reflect acute pericarditis, as is often seen in patients without LBBB. In addition, the ECG shows concomitant PR depression and STE in the inferolateral leads that is compatible with, though not diagnostic of, acute pericarditis. It should be remembered that PR depression (especially focal) can be seen in patients with AMI.⁵ Interestingly, we were not able to find previous descriptions of ECG changes of acute pericarditis in patients with LBBB.

The patient received intravenous 250mg albumin. Hypotension resolved. Cardiac troponin or additional imaging have not been ordered and the patient was discharged the next day. Repeat ECG on a routine outpatient visit 10 days after discharge showed sinus rhythm. LBBB resolved. Diffuse mild STE with prominent J-points in the inferolateral leads and ST depression in aVR were seen. This ECG was compatible with pericarditis or early repolarization.⁶ The prominent J points are in favor of early repolarization and the ECG prior to surgery shows minimal STE with prominent J-points, are in favor of early repolarization. An ECG one year later continued to show diffuse STE with prominent J-points compatible with early repolarization. Thus, it could be that he had pericarditis on top of baseline early repolarization.

In the presented patient, hypotension was probably secondary to hypovolemia, as it resolved after infusion. Transient LBBB can occur after aortic valve replacement and the diffuse STE was probably secondary to pericardial inflammation post-surgery.

Teaching points:

New LBBB in isolation is not predictive of AMI.

LBBB with concordant ST elevation should be considered as a sign of occlusion MI but occasionally may be associated with other conditions such as pericarditis.

At the time the ECG was performed, the clinical presentation along with the ECG changes could have been compatible with AMI, iatrogenic aortic dissection, or cardiac tamponade.

Bedside transthoracic echocardiogram to rule out pericardial effusion, regional wall motion abnormalities and dissection flap in the aortic root should be ordered; however, the accuracy of echocardiogram to detect regional wall motion abnormalities in patients with LBBB presenting with AMI is low due to desynchrony and presence of previous wall motion abnormalities⁷.

This could be followed by computerized tomography angiography of the aorta and the coronary arteries if suspicion of aortic dissection or AMI remains.

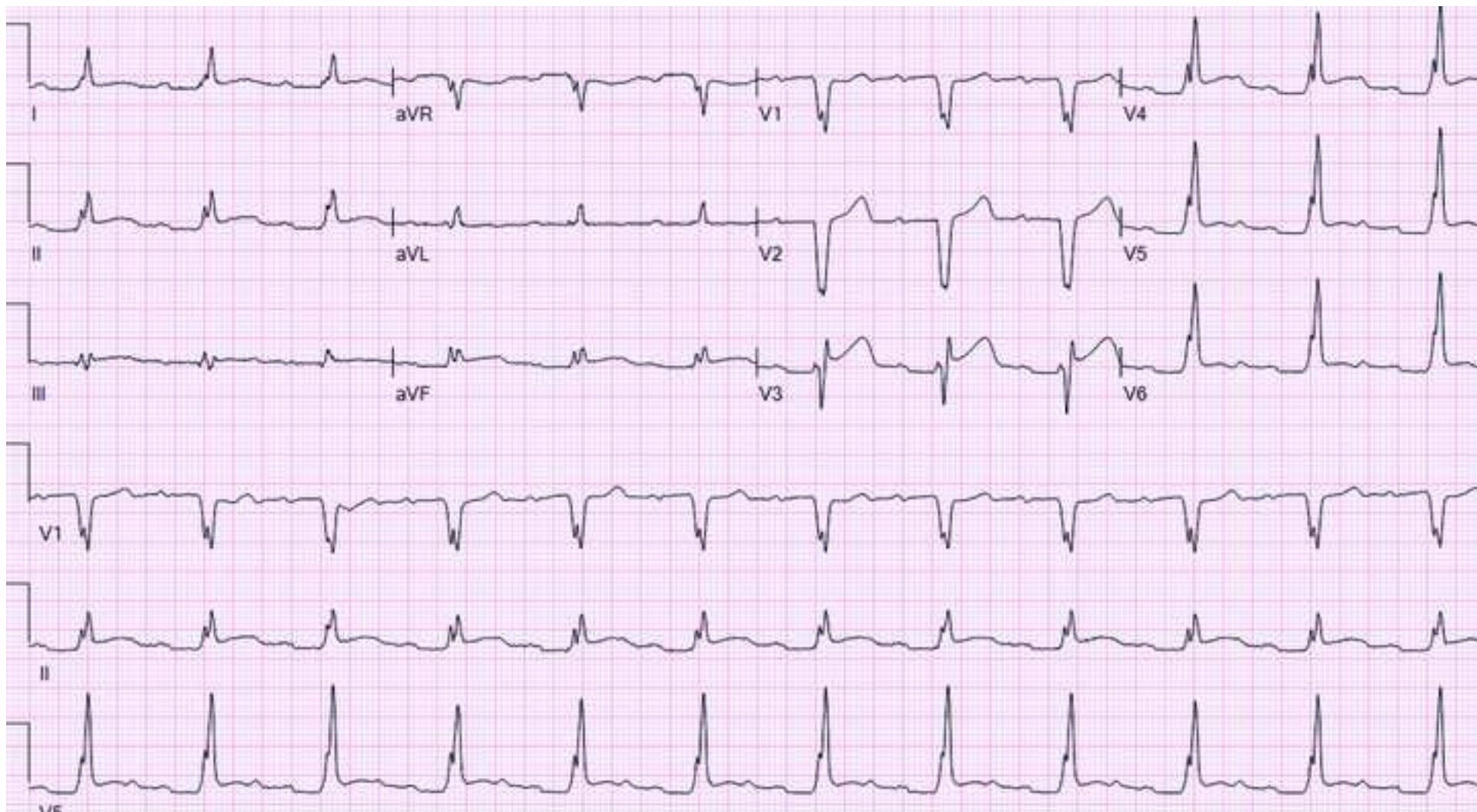
Thus, the right answer is **7**- "Further workup is needed to make the diagnosis".

Figure 1: ECG at day 5 after surgery. Sinus rhythm with first degree AV block. There is PR segment depression in II, aVF, V3-V6. There is new onset LBBB with QRS duration of 148 msec. There is concordant ST elevation in I, II, III, aVF, V4-V6.

Figure 2: Enlarged images of leads II and V4 showing PR depression and ST elevation concordant with the QRS direction.

References:

1. O'Gara PT, Kushner FG, Ascheim DD, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2013;127:e362-425.
2. Liu J, Birnbaum Y. ST segment elevation following coronary artery bypass surgery. *J Electrocardiol*. 2019;57:128-131.
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4. De Viti D, Dambruoso P, Izzo P, et al. Iatrogenic Acute Aortic Dissection in the Era of Minimally Invasive Cardiac Surgery - Experience of a Center and Review of Literature. *Braz J Cardiovasc Surg*. 2021;36:691-699.
5. Zhan ZQ, Nikus K, Birnbaum Y. PR depression with multilead ST elevation and ST depression in aVR by left circumflex artery occlusion: How to differentiate from acute pericarditis. *Ann Noninvasive Electrocardiol*. 2020;25:e12752.
6. Birnbaum Y, Perez Riera AR, Nikus K. PR depression with multilead ST elevation and ST depression in aVR: Is it always acute pericarditis? *J Electrocardiol*. 2019;54:13-17.
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Physicians. <https://doi.org/10.1016/j.annemergmed.2022.08.455>

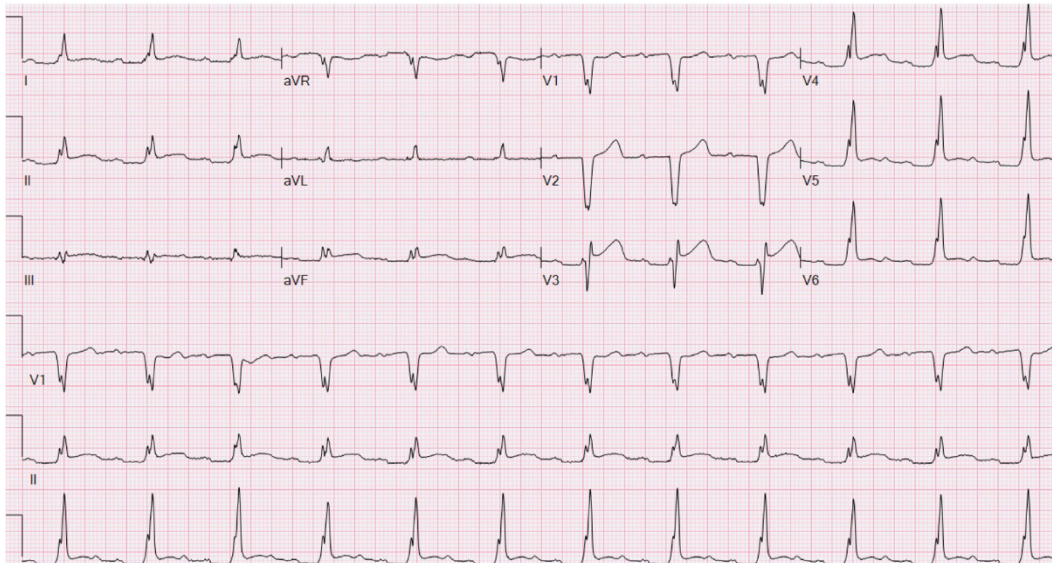


Figure 1. ECG 5 days after surgery. Sinus rhythm with first-degree atrioventricular block. There is PR-segment depression in II, aVF, V3-V6. There is new-onset left bundle branch block with a QRS duration of 148 msec. There is concordant ST elevation in I, II, III, aVF, V4-V6.

[Ann Emerg Med. 2023;81:546-549.]

A 64-year-old man with severe aortic stenosis underwent minimally invasive aortic valve replacement. Coronary angiography

before surgery revealed nonobstructive coronary artery disease. His ECG before surgery showed sinus rhythm with voltage criteria for left ventricular hypertrophy. Postoperatively he developed right pleural effusion, drained with a pigtail catheter. A computed tomography image of the chest did not show pericardial effusion. Three days after surgery, he developed atrial flutter with 4:1 conduction and a right bundle branch block that converted to sinus rhythm with intravenous amiodarone. On day 5 after surgery, he developed shortness of breath associated with hypotension. The ECG is shown in [Figure 1](#).

For the diagnosis and teaching points, see page
547. To view the entire collection of ECG of the Month, visit

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CLINICAL QUESTION

What is the diagnosis?

DIFFERENTIAL DIAGNOSIS:

1. This is acute coronary occlusion myocardial infarction, as he developed a new left bundle branch block.
2. This is an acute coronary occlusion myocardial infarction, as he has a concordant ST elevation (STE) in the inferolateral leads in a setting of the left bundle branch block.
3. The ECG changes were caused by the amiodarone infusion.
4. This is pericarditis.
5. This is early repolarization.
6. Nonspecific ECG changes after heart surgery.
7. Further workup is needed to make the diagnosis.

INTERPRETATION

The ECG before surgery showed sinus rhythm with voltage criteria for left ventricular hypertrophy. There were prominent J-points with minimal STE in the inferior leads pV5-V6 and J-point elevation in V2-V4, compatible with normal variant early repolarization. **Figure 1** shows sinus rhythm with first degree atrioventricular block. There is PR-segment depression in II, aVF, V3-V6. There is new-onset left bundle branch block (QRS duration of 148 msec). A concordant STE can be observed in I, II, III, aVF, V4-V6 (**Figure 2**).

DISCUSSION

In a patient who is hypotensive after aortic valve replacement, the differential diagnosis is extensive and includes bleeding, hypovolemia, valve malfunction, ischemia, pericardial effusion with tamponade, and aortic dissection. The ECG and bedside transthoracic echocardiogram to rule out pericardial effusion, regional wall motion abnormalities, and dissection flap in the aortic root should be ordered; however, the accuracy of echocardiogram to detect regional

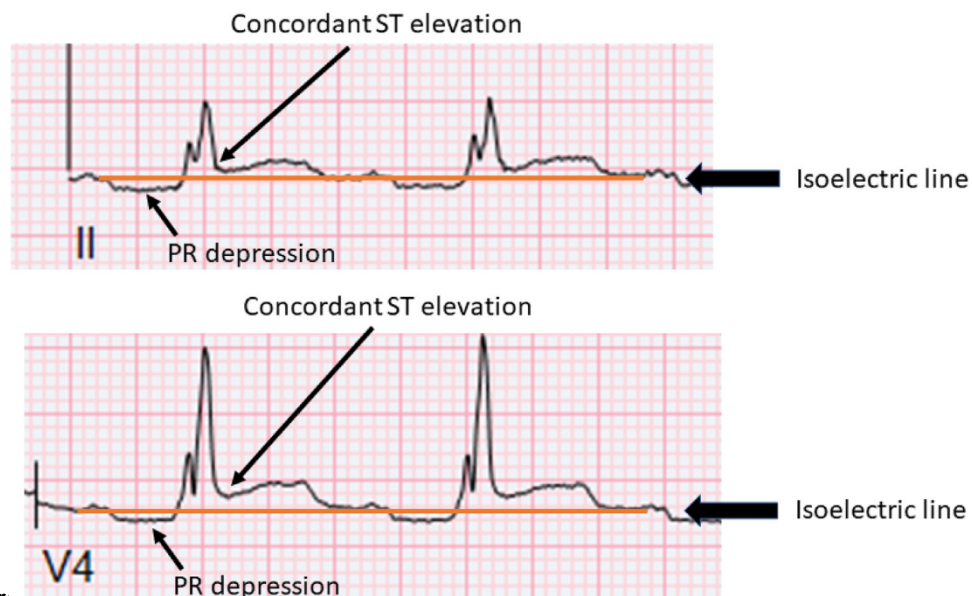


Figure 2. Enlarged images of leads II and V4, showing PR depression and ST elevation concordant with the QRS direction.

is low because of desynchrony and presence of previous wall motion abnormalities.

The 2013 American College of Cardiology Foundation/American Heart Association Guideline for the Management of STE myocardial infarction states: "New or presumably new left bundle branch block at presentation

occurs infrequently, may interfere with STE analysis, and should not be considered diagnostic of acute myocardial infarction in isolation."

according to Sgarbossa et al

2 Concordant STE is,

4 Diffuse concordant ST deviation in a patient with a left bundle branch block may also reflect acute pericarditis, as is often seen in patients without a left bundle branch block. In addition, the ECG shows concomitant PR depression and STE in the inferolateral leads that are compatible with, though not diagnostic of, acute pericarditis. It should be remembered that PR depression (especially focal) can be seen in patients with acute myocardial infarction.

6 The prominent J-points favor early repolarization, and the ECG before surgery shows minimal STE with prominent J-points, which favor early repolarization. An ECG one year later continued to show diffuse STE with prominent J-points compatible with early repolarization. Thus, it could be that he had pericarditis on top of baseline early repolarization.

In the presented patient, hypotension was probably secondary to hypovolemia, as it resolved after infusion. Transient left bundle branch block can occur after aortic valve replacement, and the diffuse STE was probably secondary to pericardial inflammation after surgery.

PEARLS

- A new left bundle branch block in isolation is not predictive of acute myocardial infarction.
 - Left bundle branch block with concordant ST elevation should be considered as a sign of occlusion myocardial infarction but occasionally may be associated with other conditions such as pericarditis.
- At the time the ECG was performed, the clinical presentation along with the ECG changes could have been compatible with acute myocardial infarction, iatrogenic aortic dissection, or cardiac tamponade.
- Bedside transthoracic echocardiogram to rule out pericardial effusion, regional wall motion abnormalities, and dissection flap in the aortic root should be ordered; however, the accuracy of an echocardiogram to detect regional wall motion abnormalities in patients with left bundle branch block presenting with acute myocardial infarction is low due to desynchrony and presence of previous wall motion abnormalities.

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REFERENCES

1. O'Gara PT, Kushner FG, Ascheim DD, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the

- American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines. *Circulation*. 2013;127:e362-425.
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