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## CASE REPORT

# Early diastolic heart sounds caused by the atrial kick

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## Abstract

An 81-year-old male with a history of coronary artery disease, hypertension, paroxysmal atrial fibrillation and chronic kidney disease presents with asymptomatic bradycardia. Examination was notable for an early diastolic heart sound. 12-lead electrocardiogram revealed sinus bradycardia with a markedly prolonged PR interval and second-degree atrioventricular block, type I Mobitz. We review the differential diagnosis of early diastolic heart sounds and present a case of Wenckebach associated with a variable early diastolic sound on physical exam.

## KEYWORDS

atrioventricular block, diastolic heart sounds, third heart sound (S3)

## 1 | OBJECTIVE

1. To review the differential diagnosis of early diastolic heart sounds.
2. To understand the physiology of heart sounds and connect physical exams to findings on ECG and echocardiogram.

## 2 | CASE REPORT

An 81-year-old male with a history of coronary artery disease s/p three-vessel coronary artery bypass surgery, hypertension, paroxysmal atrial fibrillation and chronic kidney disease presents to clinic for evaluation of bradycardia. Vital signs included a heart rate of 45 beats per minute and a blood pressure of 143/71 mmHg. Cardiac examination was notable for an irregular rhythm, early diastolic sound, normal jugular vein pressure, normal left ventricle (LV) impulse, no S4, no murmurs and no oedema.

On electrocardiogram (ECG), patient was found to have sinus bradycardia with second-degree Mobitz type I and a markedly prolonged PR interval. Transthoracic echocardiogram was notable for an ejection fraction of 70%–75% and mild concentric left ventricular

hypertrophy but normal diastolic function. Mitral inflow pulsed wave Doppler (Figure 1a) showed A waves augmenting the E waves with the prolonged PR interval. Phonocardiogram and simultaneous ECG tracings (Figure 1b) demonstrated that the additional heart sound varied slightly in timing after S2 and corresponded to the P-wave on ECG. Augmentation of physiologic rapid ventricular filling by atrial contraction generated the early diastolic sound.

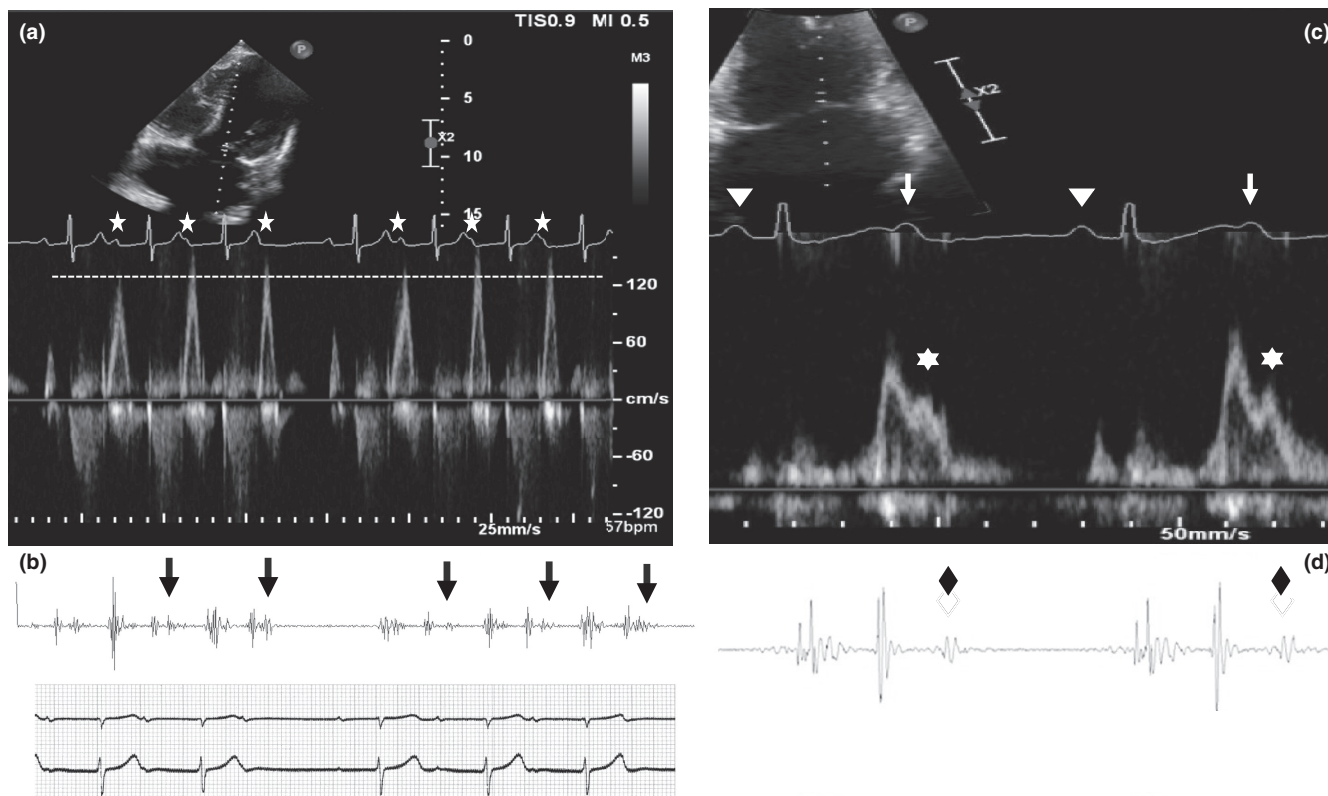
## 3 | DISCUSSION

The differential diagnosis for an early diastolic heart sound includes S3, opening snap and pericardial knock. An S3, or ventricular gallop, occurs early in diastole and is associated with vibrations caused by rapid deceleration of blood mass into a relatively already filled chamber (such as LV systolic failure) or by an increased rate of ventricular filling that can be seen in young athletes or in patients with severe mitral regurgitation (Abrams, 1978; Manson et al., 1995). In our patient, there was no evidence for other causes of an early diastolic heart sound such as mitral stenosis or constrictive pericarditis.

Prior studies note that an S4 in the setting of heart block, congestive heart failure and hypertrophic cardiomyopathy can cause

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**FIGURE 1** (a, b) Patient exhibiting second-degree type 1 AV block. (a) Mitral inflow pulsed wave Doppler with isolated A waves augmenting E-waves. P-waves occurring closer to T-wave cause E-A fusion with augmentation of E wave (stars). Dotted line demonstrates the degree of augmentation as the P-wave occurs closer to T-wave. (b) Phonocardiogram of patient exhibiting early diastolic sound (arrows) with corresponding electrical rhythm showing second-degree type 1 AV block. (c, d) Patient exhibiting 2:1 AV block. (c) Mitral inflow pulsed wave Doppler on echocardiogram. (d) Phonocardiogram at second right intercostal space. Conducted P-waves (arrowheads) are followed by non-conducted P-waves (arrows) in the setting of heart block. The early diastolic sound (diamonds) on phonocardiogram correlates with augmentation of the E wave (asterisks) during early passive filling that is seen on pulsed wave Doppler.

an early diastolic sound (Konishi et al., 2015; Yokota et al., 2017). Another diastolic finding could be diastolic MR that has been described with certain conditions such as AV block but is usually of low velocity so that it might not be heard (Agmon et al., 1999). The early diastolic sound heard in our patient was not that of a typical ventricular gallop. Although temporally consistent with an S3, the timing of this heart sounds after S2 slightly shortens with progressive prolongation of the PR interval, due to second-degree type I AV block, confirmed on both pulsed wave Doppler and phonocardiogram. The timing of the P-wave near the T-wave is necessary to generate this heart sound and can also be seen in certain patients with 2:1 AV block (Figure 1c,d). In this case, the timing of the early diastolic sound after S2 is fixed since there is no variation in the timing of the non-conducted P-wave with the T-wave. In addition, augmentation of the E-wave may lead to a more rapid deceleration of the mitral valve inflow leading to the early diastolic sound.

#### AUTHOR CONTRIBUTIONS

Kinan Bachour, Eric Mendez, Samuel Jackson, Gentian Lluri and Henry M. Honda contributed to the conception of the work, data

gathering, analysis and interpretation of the data and manuscript writing.

#### CONFLICT OF INTEREST STATEMENT

None.

#### DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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