Understanding Right Atrial Collapse: Timing Is Everything

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Pericardial effusion is relatively common in high-risk patients in acute care settings, and pericardial tamponade should be a consideration in these patients.[1,2] Acute pericardial tamponade typically presents as cardiogenic shock, whereas hypotension is uncommon in subacute (medical) tamponade caused by pericardial fluid accumulation within days to weeks.[3] Physical examination findings are notoriously nonspecific in diagnosing subacute pericardial tamponade; therefore, bedside ultrasonography can serve as an invaluable diagnostic tool.[4] Ultrasonographic examination can easily identify and grossly quantify pericardial effusion. In one study, emergency physicians detected pericardial effusion with an overall accuracy of 98%.[1] However, diagnosing tamponade typically requires careful hemodynamic assessment using comprehensive echocardiography.[4]

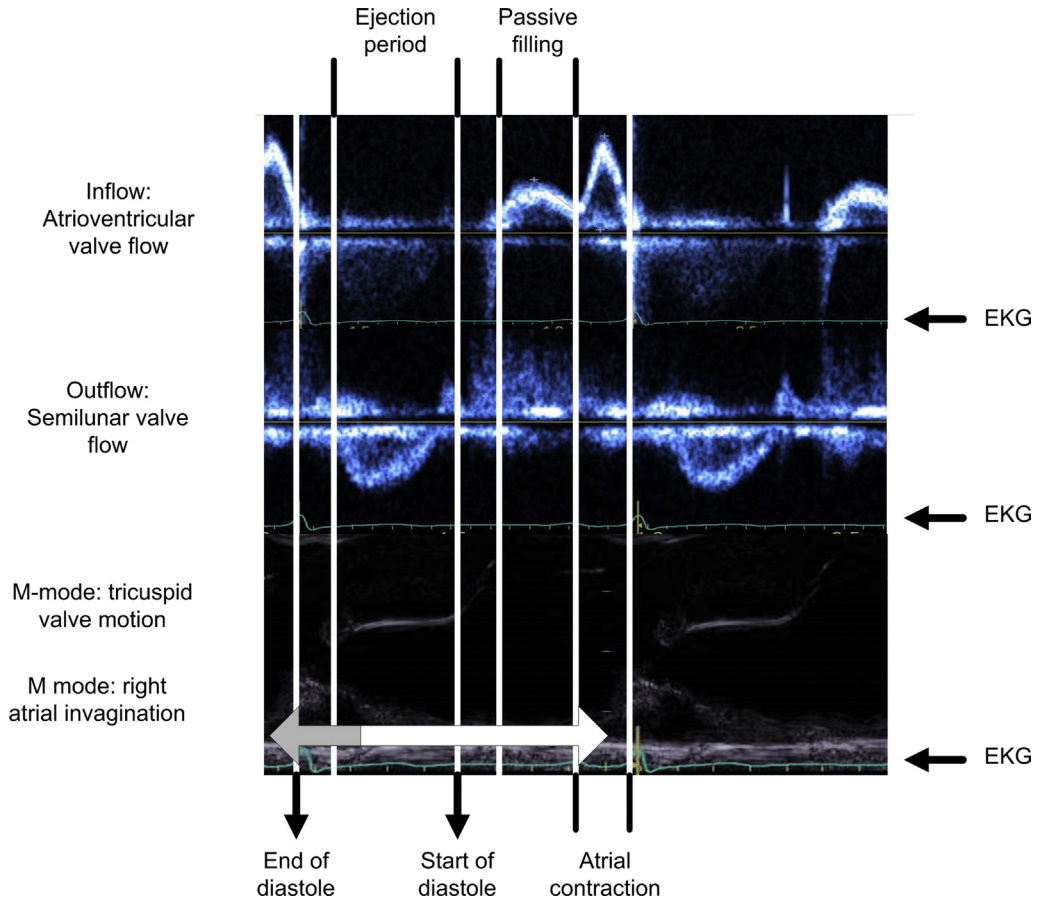

Figure 1. Timing of right atrial invagination in a patient with pericardial effusion. The right atrial inversion begins in late ventricular diastole and coincides with atrial relaxation. It may have variable extension into the ventricular ejection period. The full cardiac cycle is marked by a double-headed arrow (from start to start of inversion), and the right atrial inversion duration is highlighted in gray. The inversion time does not exceed one third of the cardiac cycle.

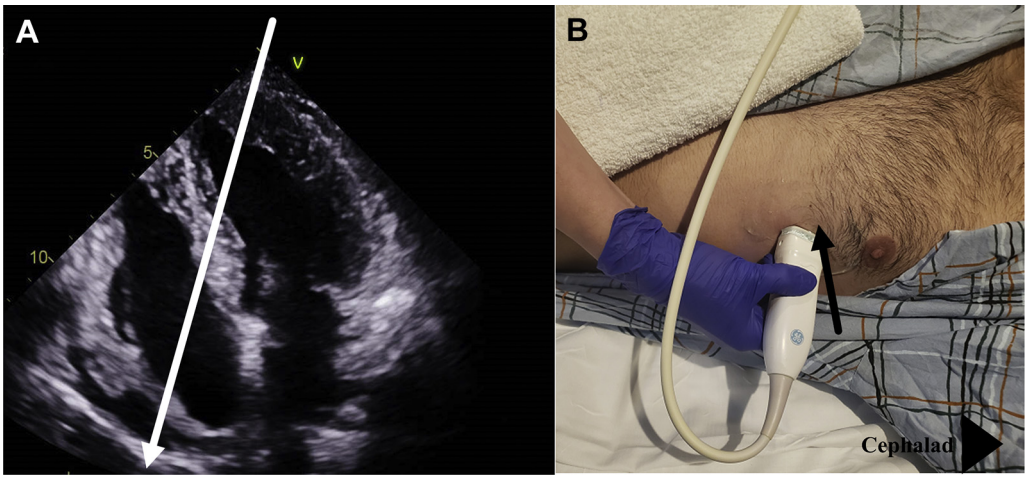

Figure 2. Modified 4-chamber view to focus on the right heart chambers. *A*, The M-mode scan line is shown by a white arrow. *B*, From the traditional 4-chamber view (black arrow), the transducer should be moved laterally with slight anterior tilt or rotation to focus on the right chambers.

Right atrial collapse has been known to be a sensitive marker of pericardial tamponade, but it can also be observed in the absence of tamponade, which limits its specificity.[4,5] The specificity of right atrial collapse can be improved if proper echocardiographic interrogation is performed. Dichotomous (yes/no) description of right atrial collapse does not provide optimal information. Right atrial collapse is explained by the fact that intrapericardial pressure transiently exceeds right atrial pressure, but the timing and duration of this finding are determined by the cardiac cycle, as well as respiratory cycle.[6] The right atrial inversion starts in very late ventricular diastole, when the intracavitary pressure is lowest (approximately at the time of the R wave on ECG) (Figure 1). The inversion continues variably into the right ventricular ejection period and may exceed one third of the cardiac cycle. The duration of right atrial collapse may vary with the respiratory cycle in chamber compression and interdependence: it is less pronounced during inspiration and more pronounced during expiration.[5] In tamponade, a prolonged right atrial collapse is typically observed during expiration coinciding with right atrial relaxation and extending into mid or late right ventricular ejection.[7] A landmark hemodynamic study demonstrated that the degree of right atrial inversion (amplitude) did not improve the predictive accuracy for pericardial tamponade, but the duration of the inversion had important implications. Specifically, a prolonged collapse exceeding one third of the cardiac cycle yielded an accuracy of 97% in diagnostic pericardial tamponade compared with a dichotomous approach, with accuracy of 85%.[8]

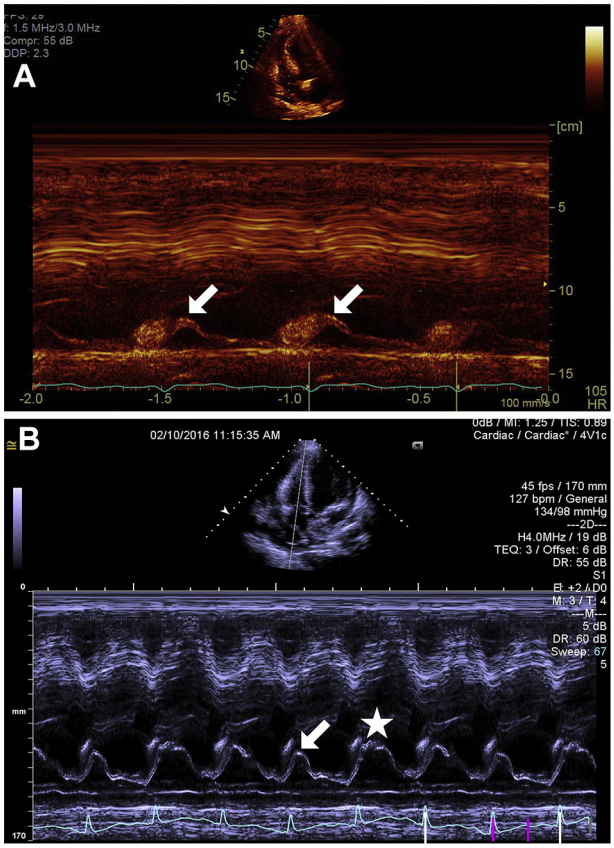

Figure 3. M-mode echocardiography obtained in the apical 4-chamber view to interrogate right atrial collapse. The scan line is passing through the right atrial wall. *A*, A brief inversion of the right atrial wall is observed in a patient with small pericardial effusion (arrows). *B*, In a patient with large effusion, phasic variation in the degree of inversion is observed. It is relatively short during inspiration (arrow), but a prolonged inversion is observed during expiration (star).

Why It Is Important
Right atrial collapse has excellent accuracy in diagnosing tamponade.
How to Obtain
Modified apical 4-chamber view focusing on the right heart chambers
M-mode echocardiography with the scan line passing through the right atrial wall
Adjusted sweep speed to capture a full respiratory cycle
What to Look For
Inward motion of the right atrial wall
Inversion starts in late ventricular diastole and variably extends into ventricular ejection.
How to Interpret
Brief right atrial wall inversion (<one third of the cardiac cycle) is nonspecific.
Prolonged right atrial wall inversion is diagnostic of tamponade.
Phasic variation in the duration of right atrial inversion may be observed in tamponade.
Caveats
Right atrial collapse may not be observed in certain situations (eg, pulmonary hypertension, right ventricular hypertrophy, localized effusion)

Figure 4. Interrogation of the right atrial collapse with suspected pericardial tamponade.

Optimized 2-dimensional echocardiographic images of the right atrium can be obtained from parasternal, apical, and subcostal windows. Unfortunately, 2-dimensional imaging does not allow easy quantification of right atrial collapse. Alternatively, M mode offers single-plane imaging with a very high temporal resolution well suited for event timing. M-mode echocardiography obtained in modified 4-chamber view and directed through the right atrial wall can properly time the right atrial wall inversion for hemodynamic assessment (Figure 2*A* and *B*). Transient right atrial wall inversion lasting less than one third of the cardiac cycle ("short-lived buckling") and without respirophasic variation is a nonspecific finding (Figure 3*A*). On the other hand, right atrial inversion that is prolonged and demonstrates phasic variation is highly accurate in confirming pericardial tamponade (Figure 3*B*).

In conclusion, careful interrogation of right atrial collapse using M-mode echocardiography, rather than dichotomous description, can serve as an important tool in diagnosing pericardial tamponade (Figure 4).

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