The Speed of Sound

Evaluating Volume Status with Ultrasound of the IVC

By Christine Butts, MD

Estimating the volume status of a patient can be challenging. Many of the classically taught physical exam findings, such as skin turgor or jugular venous pressure, can be difficult to assess. Evaluation of volume status takes on particular importance in critically ill and hypotensive patients. Ultrasound can be used quickly at the bedside to evaluate several findings that may yield clues to a patient's volume status.

Ultrasound of the inferior vena cava (IVC) has shown great promise in determining a patient's volume status, although it has not been without controversy. Ultrasound of the size and change in size with respiration in the spontaneously breathing patient has been shown to accurately correlate with central venous pressure (CVP). Controversy arises when interpreting this information. If the ultrasound evaluation of the IVC points toward a low CVP, for instance, does that mean that the patient's hemodynamic status will improve when intravenous fluids are given?

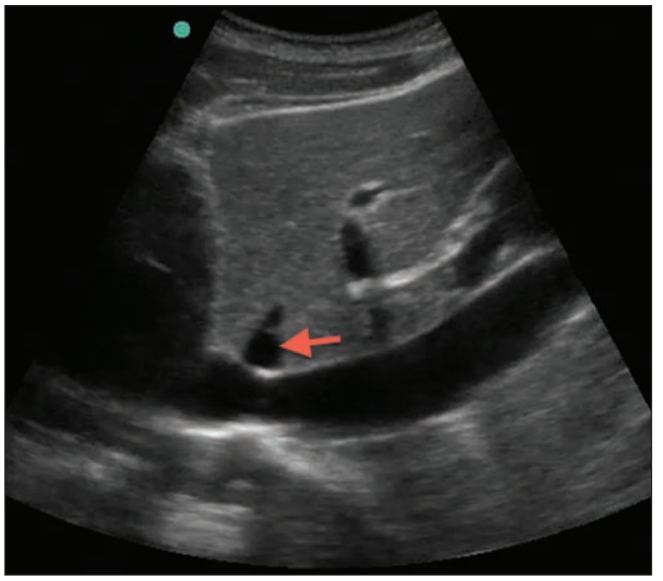

Image 1. An IVC in long axis. The junction of the hepatic vein is indicated by the arrow. This junction serves as a landmark; measurements of the IVC should be taken approximately 2 cm distal to this point.

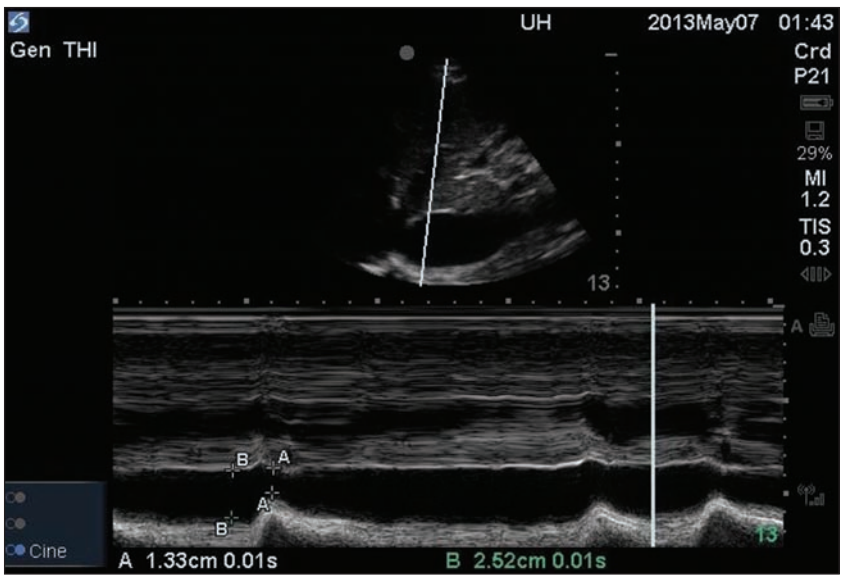

Image 2. M-mode measurements of the IVC at maximal expiratory width and minimal inspiratory width. These measurements can be used to calculate the collapsibility index (CI). The CI in this case is ([2.52–1.33] / 2.52) x 100% = 47%.

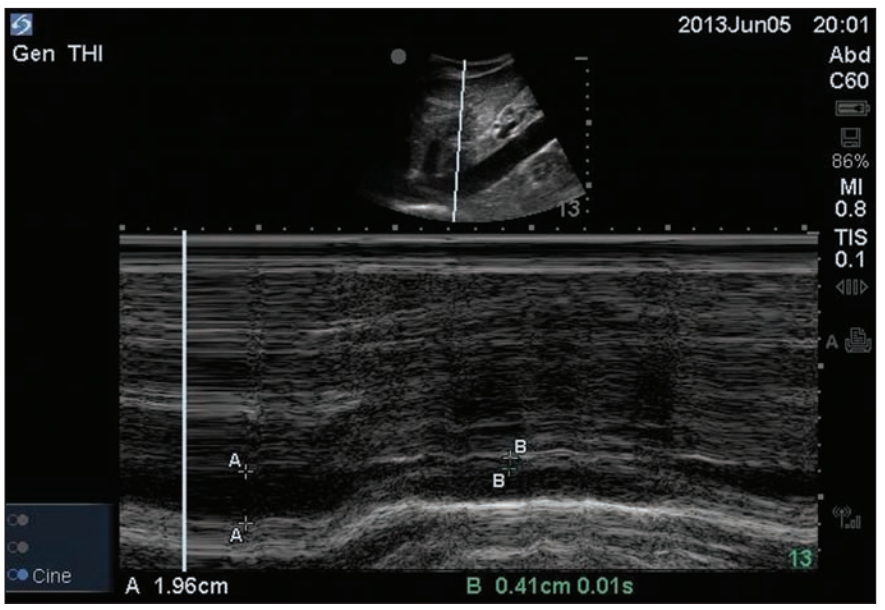

Image 3. M-mode measurements of the IVC at maximal expiratory width and minimal inspiratory width. These measurements can be used to calculate the collapsibility index (CI). The CI in this case is ([1.96–0.41] / 1.96) x 100% = 80%.

Fortunately, there's little controversy about how to perform the study. It can be performed with any type of low-frequency transducer, although the curvilinear transducer may offer the clearest image. The IVC can be imaged in short axis, but long axis offers the advantage of seeing the vessel in its full length. The transducer is placed just inferior to the xiphoid process in the midline to obtain this image. (The indicator should be pointing toward the patient's head.)

The transducer is then slowly moved toward the patient's right until the IVC is visualized. (Image 1.) The IVC is distinguished by its respiratory variability, its close proximity to the liver, and its termination into the right atrium. The IVC should be evaluated for size and amount of collapse with respiration, just distal to the junction of the hepatic veins.

Most studies have used a size of 2 cm as a midpoint in assessing CVP. An IVC with a diameter of less than 2 cm with a greater than 50% collapse during inspiration correlates with a lower CVP (0-5 mm Hg). Conversely, an IVC with a diameter of greater than 2 cm with a collapse of less than 50% during inspiration correlates with a higher CVP (10-20 mm Hg).

The CVP can be helpful, but the question that most clinicians have when evaluating a patient is whether to administer fluids. Controversy arises when attempting to determine fluid responsiveness based solely on evaluation of the IVC. A recent article by Lanspa et al addresses this issue head-on, and although it is only a pilot study, it appears to conclude that a few tweaks to our IVC measurements can reliably predict the responsiveness of the patient. (*Shock* 2013;39[2]:117.)

This study utilizes the IVC collapsibility index, which uses M-mode to calculate the formula ([IVC diameter in expiration – IVC diameter in inspiration] / IVC diameter in expiration] × 100%. (Images 2, 3.) The greater the percentage, the more likely the patient is to respond to a fluid challenge.

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