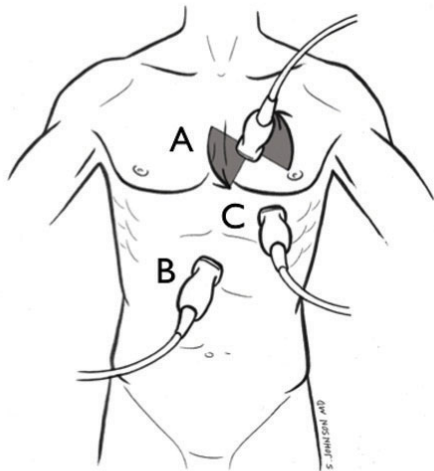


Rapid Ultrasound in SHock: The RUSH Protocol

Figure 1. Evaluation of the Pump



- A. Parasternal views (long/short axis)
- B. Subxiphoid view
- C. Apical view

EVALUATION OF THE PUMP: THE SUBXIPHOID AND APICAL VIEWS

Last month's discussion of the RUSH protocol focused on echocardiography, or assessment of the "pump,"—specifically, the parasternal views of the heart. This month, the remaining two views, the subxiphoid and apical views, will be discussed (Figure 1). Skilled use of bedside ultrasound to obtain echocardiographic views will enable the emergency physician to accomplish the primary cardiac goals of RUSH: to assess the critical patient for pericardial effusions and possible cardiac tamponade, global left ventricular contractility, and right ventricular strain.

The Subxiphoid View

Many emergency physicians are experienced in obtaining the subxiphoid view of the heart as part of the FAST (focused assessment with sonography in trauma) exam. This view is best achieved using a small footprint phased-array probe at about 3 MHz. For the four-chamber subxiphoid view, place the probe just inferior to the xiphoid tip of the sternum, with the probe marker oriented toward the patient's right side (Figure 2). To confirm optimal probe positioning, feel for the inferior tip of the sternum using the index finger of your nondominant hand. Then, using your dominant hand, place the probe directly at this position. In this exam, you are imaging the heart superiorly in the chest cavity from an inferior position in

the abdomen. Thus, the probe must be angled superiorly along the frontal plane under the sternum. To attain this angle, place the probe flat on the abdomen while aiming toward the chest. Use your dominant hand to push the probe down toward the spine and superiorly toward the chest. Keep your fingers on top of (not wrapped around) the probe to aid in proper angling. Additionally, ensure that the probe is aimed toward the left shoulder in order to display all cardiac chambers.

The subxiphoid four-chamber view allows optimal imaging of the heart (Figure 3). Because the liver acts as an acoustic window to the heart from the subxiphoid approach, a segment of liver near the probe will be visualized. The right ventricle will then be seen, adjacent to the liver. The left ventricle will be noted as a more muscular cavity directly posterior to the right ventricle. Fanning the probe medially can aid in visualizing the atria and cardiac valves. The right atrium and tricuspid valve are often seen to the right of the right ventricle. Similarly, the left atrium and mitral valve can be seen to the right of the left ventricle. The pericardial lining will be seen as a thick white line surrounding the heart. In the normal heart, there will be no significant dark or anechoic fluid collections in the pericardial sac.

The subxiphoid view of the heart provides an excellent means of accomplishing the first goal of the RUSH cardiac exam: the evaluation for a pericardial effusion. Often, an effusion is first seen as a dark or anechoic stripe accumulating adjacent to the dependent pericardial wall. As effusions enlarge,

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they wrap around the heart and are seen adjacent to both the near- and far-field pericardial walls. If a significant pericardial effusion is noted, the physician can then look specifically for signs of cardiac tamponade. This is usually manifested by diastolic collapse of the right atrium and/or right ventricle.

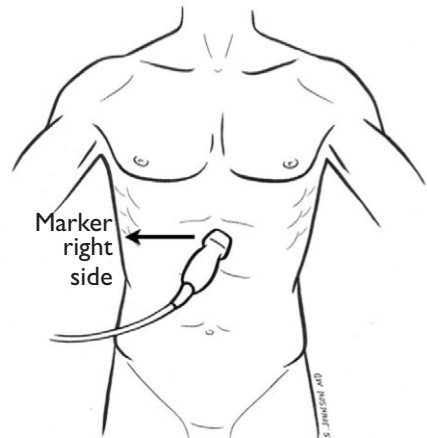
The physician can then move on to the second goal of the RUSH cardiac exam: determination of cardiac contractility. By observing the relative percentage change in the inward movement of the left ventricular endocardial walls from relaxation during diastole to contraction during systole, one can quickly assess the overall contractility of the left ventricle.

The last goal of the “pump” evaluation, analysis for right ventricular strain, must be performed cautiously from the subxiphoid view. It is important to fan the probe all the way through the right ventricle in order to avoid underestimating the ventricle’s dimensions, as the ultrasound beam can “slice off” to the side of the ventricle from this view.

The physician can also obtain the subxiphoid two-chamber view using the same probe position described above. For this view, the probe marker is rotated so that it is pointed toward the ceiling. The two-chamber view will image the ventricles well, with the right ventricle seen above the left ventricle. From the midline subxiphoid position, the aorta can often be seen in long axis, heading longitudinally downward from chest to abdomen. By moving the probe slightly to the patient’s right side, you will be able to visualize the inferior vena cava in a long-axis plane. Looking closely at the size and respiratory dynamics of the inferior vena cava at a position 2 cm proximal to the junction with the right atrium will allow assessment of the “fullness of the tank,” or filling of the core vascular circuit, which we will discuss in upcoming segments. Using the subxiphoid two-chamber view to first locate the aorta and then the inferior vena cava is a helpful, organized approach to finding these structures.

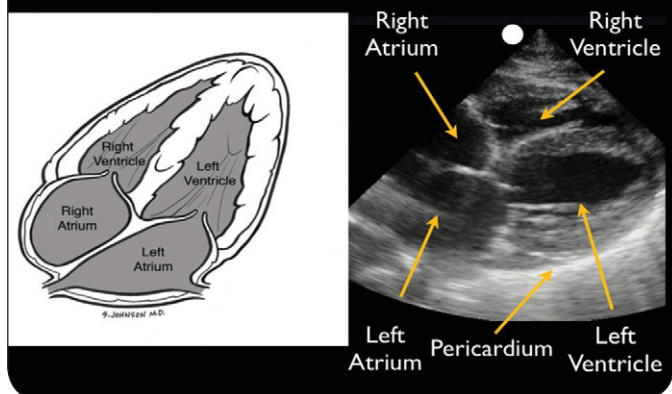
The cardiac images obtained by the subxiphoid view are normally excellent; however, this view may be difficult to attain in patients with abdominal pain or distention that does not allow the physician to push down on the probe sufficiently to achieve the upward angle needed to image the heart under the sternum. In these patients, the parasternal and apical views of the heart should be utilized. Another potential challenge arises when it is necessary to image through a gas-filled stomach in a patient who may have recently eaten. In these cases, moving the probe to the patient’s right, while still aiming toward the left shoulder to take advantage of the liver as an acoustic window to the heart, will often allow successful imaging from this plane.

Figure 2. Subxiphoid View of Heart



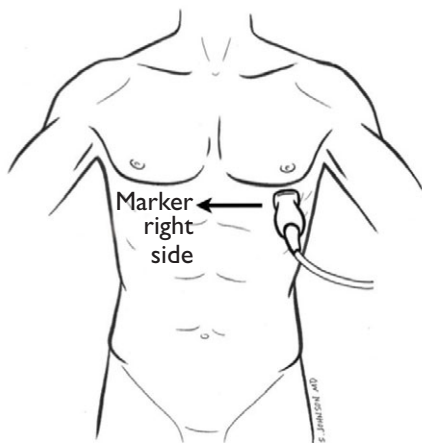
- Probe placed under xiphoid tip of sternum
- Aim probe down toward spine and superiorly toward chest
- Marker to right side
- Ultrasound screen indicator to left

Figure 3. Echocardiography: Subxiphoid View



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Figure 4. Apical View of Heart



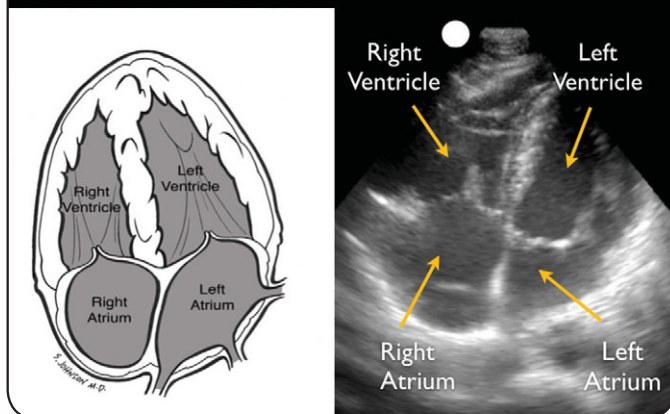
- Left lateral decubitus position improves image
- Probe placed under left nipple
- Point maximal impulse of heart
- Marker to right side
- Ultrasound screen indicator to left

The Apical View

The final cardiac view, the apical approach, enables the physician to view all four cardiac chambers in relation to one another. It offers a great deal of information about the patient's heart and is thus often preferred by cardiologists. For this view, move the patient into the left lateral decubitus position. This brings the heart closer to the chest wall. The point of maximal impulse on the lateral chest wall should be identified as the starting position for probe placement. Often this is just below the nipple line in men or under the breast in women. The probe marker should be aimed toward the patient's right side (Figure 4). The left and right ventricles will be visualized adjacent to the chest wall, as they will be closest to the probe. The atria will be seen further from the probe (Figure 5). The apical view offers a clear image of both ventricles and is particularly useful for evaluation of right ventricular strain, as manifested by a chamber size larger than the left ventricle. Pericardial effusions and left ventricular contractility are also well evaluated from this view. Interestingly, many cardiologists now use the apical transthoracic approach for pericardiocentesis because it is a safer, more direct route to the pericardial fluid than is the traditional subxiphoid approach.

The subxiphoid and apical views complement the parasternal views as part of the RUSH examination of the "pump" and are important elements of a thorough cardiac examination. Since they are taken from an inferior position as compared to the parasternal views, they allow improved evaluation of the right side of the heart. This is important, since the right side of the heart, specifically the right atrium, is not well seen from the parasternal views. Because of these relative advantages, the subxiphoid and apical views are often used in sonographic assessment of transvenous pacemaker placement in the patient with symptomatic bradycardia. They allow visualization of the pacing wire as it enters the right atrium, passes through the tricuspid valve, and moves to a desired position in the right ventricle.

Figure 5. Echocardiography: Apical View



>> Look for the next segment of "Emergency Ultrasound," with case studies illustrating the clinical utility of the RUSH cardiac views.

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