The UHP Ultrasound Protocol: A Novel Ultrasound Approach to the Empiric Evaluation of the Undifferentiated Hypotensive Patient

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This report describes a novel sonographic protocol for the evaluation of the undifferentiated hypotensive patient. This protocol combines components of 3 sonographic applications: free fluid, cardiac, and abdominal aorta into a single protocol. We believe this protocol and its underlying principles should be a routine part of the empiric evaluation of the patient with undifferentiated hypotension or pulseless electrical activity. (Am J Emerg Med 2001;19:299-302. Copyright © 2001 by W.B. Saunders Company)

Many critical conditions in emergency medicine involve the use of empiric protocols or techniques to facilitate the detection of reversible and time-dependent conditions. Caring for a patient with an unknown cause of hypotension can be one of the most challenging situations in emergency medicine. We describe the use of novel focused, goal-directed ultrasound protocol as a part of the empiric evaluation of the patient with hypotension of uncertain origin. We have termed this sonographic evaluation the undifferentiated hypotensive patient (UHP) ultrasound protocol. The UHP protocol uses components of 3 accepted emergency department (ED) ultrasound applications: free fluid evaluation, qualitative cardiac evaluation, and abdominal aorta evaluation. The rationale for the UHP protocol is to facilitate the rapid and systematic evaluation of reversible causes of hypotension when the clinical history is limited or unknown. We describe 3 actual cases where the UHP protocol was pivotal in the emergency evaluation of an undifferentiated hypotensive patient. A description and discussion of the protocol follow the case presentations. We believe this sonographic approach to be an important addition to the role of emergency ultrasound for the practicing emergency physician.

CASE 1

A 70-year old woman is brought to the ED for evaluation of syncope after being found on the floor by family members. The patient had complained earlier in the evening of a "stomach ache" and gone to bed early. Family members remarked to the paramedics that they heard a crash in the woman's room and immediately went to investigate where she was found on the floor. At the time of arrival in the ED her blood pressure was 80/palpation, heart rate of 120 beats/min, respiratory rate of 30 breaths/min. Her pulse oximetry was 100% on high flow oxygen. The only past medical history available was hypotension for which she took a single unknown prescription medication. On examination she was mumbling and disoriented. There was no gross evidence of trauma. Her chest was clear to auscultation and her heart is regular without murmurs. Her abdomen was obese and soft without apparent masses. Mild tenderness, without peritoneal signs, was noted in the midepigastrium. Initial standard resuscitative measures included crystalloid infusion. An electrocardiogram (ECG) was obtained and was normal. While awaiting the return of the portable chest x-ray machine, the UHP ultrasound protocol was performed as a routine component of her hypotension evaluation. The hepatorenal interface view showed grossly normal anatomy without evidence of free intraperitoneal fluid. The cardiac view revealed normal cardiac activity without pericardial effusion. Evaluation of the aorta revealed a 6-centimeter aneurysm with associated intraluminal clot. The vascular surgeon on call was immediately notified and the patient was taken directly to the operating room where her aorta was successfully repaired. The total time in the ED was less than 20 minutes.

CASE 2

A 40-year old woman with a significant prior history of systemic lupus erythematosus (SLE) and recurrent pulmonary embolus arrived in the ED with the chief complaint of shortness of breath. She stated that her symptoms had been progressive over the past several days and associated with a mild diffuse chest "tightness." Her review of systems was notable for an absence of fever, peripheral edema, and cough. On initial examination she was speaking in full sentences and had normal vital signs including a room air oxygen saturation of 99%. Her chest was clear and her heart regular in rate and rhythm. A chest radiograph revealed mild cardiomegaly and clear lung fields. Her ECG was within normal limits with the exception of questionably low voltage. She had a precipitous drop in her blood pressure and on re-evaluation was in obvious distress. She was cool and diaphoretic complaining of shortness of breath. Although the initial impression was a recurrent pulmonary embolism, the UHP protocol was performed as part of the evaluation of

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her undifferentiated hypotension. Her hepatorenal and aortic views were normal. Her cardiac view showed a circumferential pericardial effusion. Her cardiac contractility was vigorous and right ventricular diastolic collapse was also evident. The diagnosis of pericardial effusion with tamponade was made and she underwent emergent pericardiocentesis removing 1 L of nonclotting pericardial blood. She ultimately made an uneventful recovery and was discharged home.

CASE 3

A 45-year man was brought to the ED with hypotension with a complaint of severe left flank pain. The patient is non-English speaking. A limited history from paramedics stated that he had been feeling ill for 3 days and was recently placed on a quinolone antibiotic for presumed pyelonephritis. The patient is unable to give any history. Past history was unknown. Physical examination revealed an agitated man who was diaphoretic and in obvious distress. His vital signs were blood pressure of 78/40 mm Hg; pulse rate of 120 beats/min; respiratory rate of 30 breaths/min; temperature 36°C rectal; and oxygen saturation of 100% on oxygen. The physical examination was most notable for left flank tenderness. Appropriate resuscitative measures were undertaken including volume resuscitation with crystalloid fluids. Chest x-ray film and ECG were unremarkable. The UHP scan was used as a standard part of the patient's evaluation. A hepatorenal interface view (morison's pouch) revealed a large anechoic signal consistent with free intraperitoneal fluid. Parasternal short axis cardiac views revealed strong cardiac activity and no pericardial effusion. The UHP aorta evaluation was normal. After 3 L of crystalloid fluid the patients blood pressure increased to 100/60 mm Hg. Given the patients clinical condition, the anechoic signal was presumed to be blood and trauma surgery was immediately notified. The patient was taken for emergent laparotomy and where a bleeding subcapsular hematoma of the spleen was found requiring splenectomy. A later history through translation revealed that the patient had fallen off a ladder 3 days prior and injured his left chest wall.

DISCUSSION

The UHP protocol consists of components of 3 accepted ED ultrasound applications combined into a single protocol for the evaluation of reversible causes of hypotension: free intraperitoneal fluid evaluation, focused cardiac examination, and focused abdominal aorta evaluation. This ultrasound protocol provides key elemental data when faced with a patient with shock of unclear origin with particular emphasis on hemoperitoneum, pericardial effusions, and aortic aneurysms. To our knowledge, this is the first description of such a sonographic protocol. The purpose of this protocol is to have a standardized ultrasound approach to the undifferentiated hypotensive patient that allows for the systematic evaluation of reversible and time-dependent causes of hypotension.

The UHP protocol is based on a few underlying principles: (1) The patient is hypotensive; consequently, causes detectable normally by ultrasound would likely be more apparent. (2) The UHP examination is meant to be a systematic approach rather than a defined number of transducer positions. The basic UHP examination has 3 examination positions to minimize the time needed for the protocol but each component may be augmented as needed for a given clinical situation. (3) Like all ED ultrasounds, these are focused, goal-directed examinations to help answer a clinical question but may not definitively exclude a condition.

Further imaging and evaluation may still be required to adequately exclude a given condition. The protocol consists of 3 components. Each component can be performed in any order although we will describe the protocol in the most practical sequence. Obviously the patient's clinical condition and relevant history may alter the order and/or detail of each of the components. For example, a patient with SLE and profound hypotension nearing pulseless electrical activity (PEA) should have the cardiac component looking for a pericardial effusion with tamponade first. Likewise, an elderly patient with a history of hypotension who is now hypotensive and complains of abdominal and back pain should first have the aortic component to evaluate for an abdominal aortic aneurysm. Regardless, it is important to think of the UHP protocol as part of the empiric evaluation of the undifferentiated hypotensive patient. This protocol may also be applied to patients in presumed PEA as the protocol covers components in the differential of PEA (hypovolemia and pericardial effusion).

Figures 1 through 4 illustrate the standard examination positions for the UHP protocol. Each examination area gets a minimum of a single view. Each view is the representative window most likely to give the desired clinical information. A 3.5 MHz transducer is sufficient for all views. Any size footprint transducer is acceptable for the protocol though a microconvex is ideal for both intercostal and abdominal views. Free fluid evaluation is through a single hepatorenal interface view (Morison's pouch) adopted from the F.A.S.T. (focused abdominal sonography in trauma) examination.[1] Cardiac evaluation is through a single subxiphoid view. A parasternal view may be substituted. The aortic evaluation is a transverse evaluation sweeping from the substernal position down to the bifurcation of the iliac vessels. The progression from the hepatorenal interface to the substernal view sweeping through the transverse aortic evaluation is meant to follow an orderly and technically logical progression. Each view can be augmented depending on the given clinical situation. An underlying principle of the UHP protocol is that the patient is hypotensive; thus, the conditions covered by the protocol should be readily detected.

LIMITATIONS

Many causes of profound hypotension are time-dependent and the empiric application of an ultrasound examination can facilitate their detection. Incorporating the 3 focused ED ultrasound examinations useful in evaluation of the hypotensive patient into a single protocol allows for a more systematic approach to this problem. However, each component has limitations and these need to be understood when using the protocol.

First, the use of a single-view of morison's pouch for free fluid evaluation has limitations. Ma et al evaluated single versus multiple views for the F.A.S.T. examination. Single

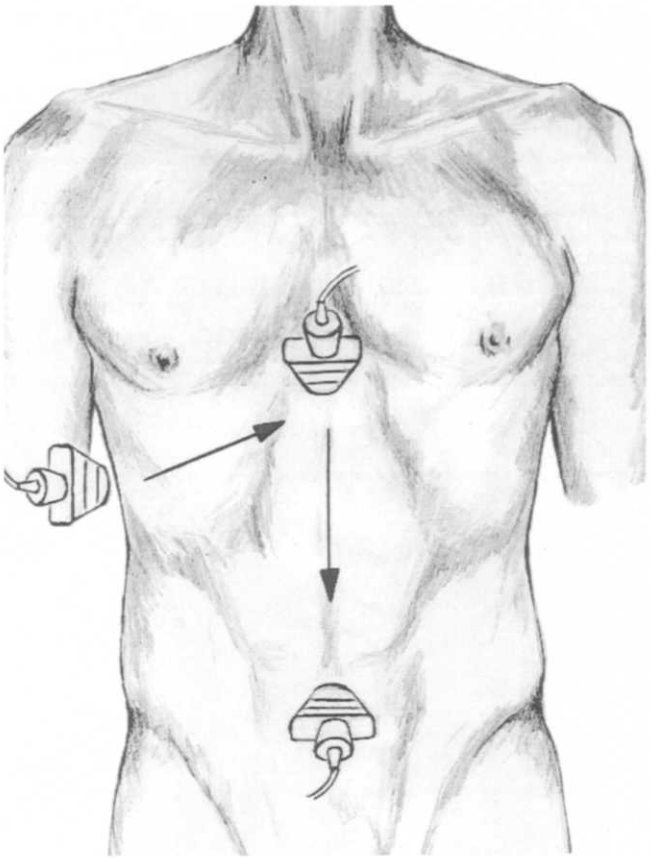

FIGURE 1. Three standard positions in the UHP ultrasound protocol: hepatorenal (Morison's pouch), transverse subxyphoid cardiac, and sweeping transverse of aorta down to iliac vessels. Copyright © John S. Rose, MD and Aaron E. Bair, MD. Reprinted with permission.

view of the hepatorenal interface had a sensitivity of 51% (95% CI 34-68%) and specificity 100% (95%CI 98-100%) versus the multiple view which had a sensitivity of 87% (95%CI 71-96%) and a specificity of 100% (95% CI 97-100%).[2] However, given that patients who undergo the UHP protocol are hypotensive, the sensitivity of a single view may be higher since a larger volume of hemoperitoneum would more likely be present. This hypothesis has yet to be confirmed. It is important to understand that the UHP protocol is not meant to be the definitive study but a component of the empiric evaluation of the undifferentiated hypotensive patient. If the clinical scenario supports a traumatic origin, a more complete F.A.S.T. examination is indicated.

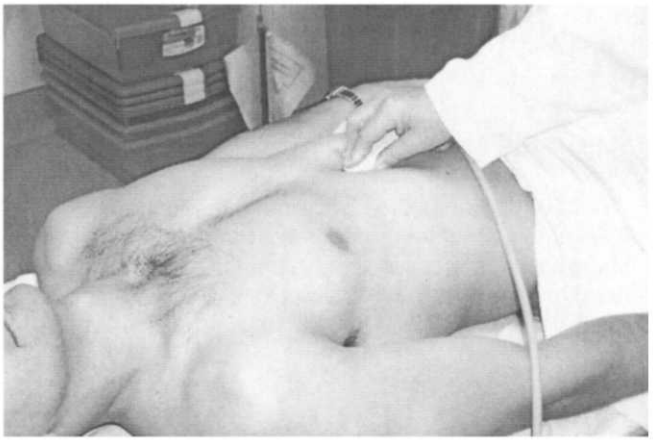

FIGURE 3. Transverse subxyphoid view.

Focused, goal-directed cardiac evaluation performed by emergency physicians evaluating for qualitative cardiac activity and clinically significant pericardial effusions has been studied. Plummer et al showed that emergency physicians could detect pericardial fluid with resulting tamponade with a single view.[3] Because pericardial effusion causing tamponade are sonographically apparent, a single view may be all that is required. Again if the clinical scenario warrants a more thorough evaluation, a comprehensive ECG can be performed.

Ultrasound is an accepted imaging test for abdominal aortic aneurysms (AAA) and is very accurate when used as a screening modality in unstable patients in the emergency department.[4,5] Most AAAs are fusiform and reliably seen in the transverse view although the transverse view can miss the less common saccular aneurysm. Transverse views do give accurate measurements of aortic diameter, the most relevant ultrasonographic finding in an AAA. Obesity and bowel gas can be technical limitations in evaluating the

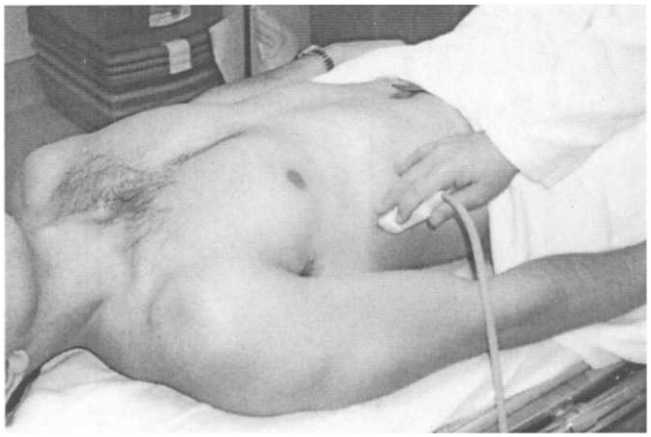

FIGURE 2. Single hepatorenal view.

Figure 4. Transverse aortic view.

abdominal aorta. If the clinical scenario is more indicative of an AAA, a more complete ultrasound imaging protocol may be used.

CONCLUSION

We have described the UHP ultrasound protocol, a novel emergency ultrasound application in the evaluation of the undifferentiated hypotensive patient. This protocol combines 3 focused ultrasound views into a single systematic approach to detect reversible and time–dependent causes of hypotension. This ultrasound protocol is an additional part in the overall empiric evaluation of the profoundly hypotensive patient when a specific cause is unknown. The UHP protocol provides a systematic ultrasound approach to a difficult clinical situation. Currently, a prospective descriptive series is underway to better define the role of the UHP protocol in the resuscitation of the undifferentiated hypotensive patient.

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