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Brief Report

Addition of a lateral view improves adequate visualization of the abdominal aorta during clinician performed ultrasound[☆]Maria Studer, MD^a, Dorothea Hempel, MD^b, Shada Rouhani, MD^c, Hana Dubsky, PA^c, Emanuele Pivetta, MD, MSc^c, Heidi H. Kimberly, MD^{c,*}^a Department of Surgery, Tiefenausspital Bern, Switzerland^b Department of Internal Medicine, Cardiology, University Hospital, Mainz, Germany^c Department of Emergency Medicine, Division of Ultrasound, Brigham and Women's Hospital, Boston MA 02115, USA

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ABSTRACT

Objective: Full visualization of the abdominal aorta using the standard midline view is often inadequate for the detection of abdominal aortic aneurysm. We evaluated whether the addition of a lateral midaxillary right upper quadrant view could improve visualization of the abdominal aorta.

Methods: This was a prospective observational proof-of-concept study of patients older than 50 years undergoing abdominal computed tomographic scan for any indication in the emergency department. Ultrasounds were performed by American College of Emergency Physicians–credentialed study sonographers, and images were reviewed by an ultrasound fellowship-trained reviewer. The standard midline aortic images were obtained as well as additional lateral images from a midaxillary right upper quadrant approach. Visualization of the aorta was determined to be adequate if more than two-thirds of the abdominal aorta was visualized.

Results: We enrolled 60 patients. Six patients were excluded due to missing data. A total of 54 patients were analyzed. The median age was 67.5, and 37% were male. The mean body mass index was 25.9 (SD, 5.8), and mean abdominal circumference was 105.3 cm (SD, 18.1). Visualization of the aorta using the midline approach was adequate in 26 (48.2%) of 54 of the patients and 32 (59.2%) of 54 of the lateral approach. Addition of a lateral view in examinations with an inadequate midline view increased adequate aortic visualization to 41 (75.9%) of 54.

Conclusion: Combining a lateral view to the standard midline approach improves adequate visualization of the abdominal aorta by approximately 28%. Further study is required to determine if the lateral view is equivalent for detecting abdominal aortic aneurysm.

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1. Introduction

Clinician-performed ultrasound (CPU) of the abdominal aorta to detect abdominal aortic aneurysm (AAA) is one of the standard emergency ultrasound applications. Diagnostic accuracy of history and physical examination are notoriously poor, and AAA carries significant mortality [1–3]. For these reasons, emergency physicians (EPs) have increasingly adopted CPU of the aorta for the rapid bedside diagnosis of AAA, and the American College of Emergency Physicians (ACEP) has developed training guidelines and credentialing standards [4].

Previous studies reported high diagnostic accuracy of EPs for the detection of AAA [5–9]. However, many of these initial studies may not be generalizable as they excluded patients in which the aorta was

not fully visualized, had only very experienced sonographers performing the examinations, or were limited by methodology such as convenience sampling, which could have resulting in excluding challenging patients.

More recent literature suggests that a significant portion of CPU aorta examinations are limited by inadequate visualization of the entire aorta. A study by Blaiwas and Theodoro [10] retrospectively analyzed 207 patients who had received emergency ultrasound to rule out AAA and found that the aorta was not seen in its entirety in 17% of patients, and in 8% of patients, a significant portion of the aorta (>1/3) was not visualized. Moore et al [11] performed screening examinations of the aorta on 179 asymptomatic male emergency department (ED) patients reporting complete visualization in only 62.6%, and in 4.5% of patients, the aorta was not visualized at all. More recently, Hoffmann et al [12] enrolled 196 asymptomatic men with AAA risk factors and found that a diverse group of ACEP-credentialed sonographers adequately visualized the aorta in 71.4%, incompletely visualized in 20.4%, and incorrectly measured in 8.2%. They found that

[☆] Results of the study were presented at 2012 ACEP Scientific Assembly in Denver, CO.

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providers with more than 3 years of experience post credentialing demonstrated better performance.

These recent studies demonstrate that in day-to-day practice, CPU of the aorta as practiced using a standard midline approach is significantly limited by inadequate visualization of the vessel. The most common factors resulting in poor ultrasound visualization include bowel gas obscuring the aorta, body habitus, symptoms such as abdominal pain causing inability to tolerate the examination, experience level of the sonographer, and limited time at the bedside. Unfortunately, the standard countermeasures for poor visualization including graded compression and patient positioning are often not well tolerated by patients. Using the liver as an acoustic window from a midaxillary lateral right upper quadrant (RUQ) approach (such as the RUQ FAST view) visualizes the aorta longitudinally and may provide additional information when a midline view is inadequate (see Fig. 1). To our knowledge, the usefulness of this lateral approach has never been specifically studied and is not typically taught or used by point-of-care sonographers.

The purpose of this study was to evaluate whether it was possible to improve adequate visualization of the abdominal aorta by supplementing the traditional midline view of abdominal aorta with a lateral RUQ midaxillary view.

2. Methods

This was a prospective observational proof-of-concept study. The study was approved by the institutional review board and was conducted in an academic emergency medicine department with an ED residency program and an annual census of more than 70000 patients. Patients older than 50 years undergoing an abdominal computed tomography (CT) for any indication while in the ED were eligible for inclusion. Exclusion criteria included pregnancy, inability to provide verbal consent, or unstable clinical condition as determined by the treating physician. Consecutive patients awaiting abdominal CT were approached by study staff based on their availability. Basic demographic information was obtained at the time of consent including age, sex, height, weight, and abdominal circumference.

Ultrasounds were performed by 5 sonographers including an emergency medicine resident, a physician assistant, an emergency medicine fellowship-trained physician, and 2 foreign trained physicians obtaining ultrasound fellowship training. All of them had performed greater than 25 aorta scans and had met ACEP credentialing requirements. Ultrasound evaluations were performed at the bedside using a 2–5 MHz curvilinear transducer on a Siemens Acuson X300 (Siemens AG, Erlangen, Germany) and Zonare Z.One Ultrasound system (Zonare Medical Systems, Mountain View, CA).

All patients were scanned in the supine position. Images of the aorta from celiac axis to the bifurcation were obtained from the following 2 approaches: (1) traditional midline transverse approach (saving a video clip of scanning down the aorta and still images of the proximal, mid, and distal aorta) and (2) lateral midaxillary longitudinal view from the RUQ tracking the aorta distally to the bifurcation. Study sonographers graded the adequacy of aortic visualization in the midline view as entire aorta visualized, limited but adequate visualization ($>2/3$ of aorta meaning measurements of proximal, mid, and distal but not full visualization between), inadequate visualization ($<2/3$ meaning only 1 or 2 of the 3 measurements could be obtained), or no view. The lateral RUQ view was graded as entire aorta visualized, limited visualization ($>2/3$ of the aorta if a longitudinal segment of >10 cm was measured), inadequate visualization ($<2/3$ of the aorta visualized), or no view. Time to acquisition of images was recorded. Images were saved as Digital Imaging and Communications in Medicine format video clips to the ultrasound machine's hard drive and later burned to DVD. Images were reviewed by a blinded ultrasound-trained emergency medicine physician. Abdominal CTs were reviewed and measured by research assistants to determine the length of the abdominal aorta and for the presence of AAA, defined as diameter greater than 3 cm.

2.1. Data analysis

Data were entered into an Excel datasheet then analyzed using STATA 12.0 (StataCorp LP, College Station, TX). Baseline characteristics were reported in counts and proportions or mean and SD values when appropriate. Univariate comparisons were made with χ^2 test. Interobserver agreement between sonographer and reviewer was assessed using Cohen's κ agreement coefficient. All tests were considered statistically significant when $P \leq .05$.

3. Results

We enrolled a total of 60 patients. Of these, 6 patients were later excluded because no images were saved after an ultrasound machine hard drive failure, leaving a total of 54 patients for review and analysis. The baseline characteristics patients are reported in the Table. The median age was 67.5 years, and 37% of patients were male. The mean body mass index (BMI) was 25.9 (SD, 5.8), and mean abdominal circumference was 105.3 cm (SD, 18.1). The mean time to perform the midline scan was 4.7 minutes (SD, 2.7); the mean time to perform the RUQ scan was 3.8 minutes (SD, 1.5).

We assessed the visualization of the abdominal aorta using the traditional midline view and the supplemental RUQ view. With the



Fig. 1. Midline aorta view with aorta in transverse (left panel). Lateral RUQ view of abdominal aorta with the aorta deep to the liver and inferior vena cava (right panel).

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