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LETTER

Transthoracic echocardiography to evaluate the superior vena cava in critically ill patients: window description and pilot study

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Dear Editor,
In critically ill patients, echocardiography is a primary tool for hemodynamic assessment. With transesophageal echocardiography (TEE) during positive pressure ventilation, detection of respirophasic variation superior vena cava (SVC) diameter is useful for identification of volume responsiveness [1, 2]. This requires an upper esophageal view with a longitudinal view of the vessel above its entry into the right atrium (RA). Several transthoracic echocardiography (TTE) views have been described for visualizing the SVC. These include a right parasternal view [3], the supraclavicular view, [4] and using agitated saline contrast to identify the SVC from a parasternal long axis view [5]. These studies were carried out in a small cohort and reported the SVC in a short axis view or at its entry into RA.

We describe imaging of the SVC using TTE from a left parasternal view and report its feasibility in critically ill patients. This study was performed as part of a larger echocardiography study which received ethics committee approval. To obtain the view of the SVC, the patient is placed in a semi-recumbent position, and the transducer is placed at the left parasternal border between the second to fourth intercostal spaces with a probe marker oriented vertically in the cephalad direction and angled medially 30°–45° from the sagittal to coronal plane (Fig. 1a, b) until the ascending aorta is visualized. The probe is further adjusted to image a longitudinal axis view of the SVC parallel and adjacent to the aorta (Fig. 1c, d, supplementary video 1). The SVC is tubular in shape and is connected to the right atrium. Nearby structures can induce confusion, including the left atrium, right upper pulmonary vein and right pulmonary artery. Injection of agitated saline contrast may be used to confirm identification of the SVC (Fig. 1e), and a central venous catheter could be imaged within the vessel (Fig. 1c and supplementary video 2). Respirophasic variation of SVC diameter can be obtained with the M mode (Fig. 1f, g).

A single operator using an echocardiography machine with a phased array cardiac probe (VividS70 or VividE9; GE Healthcare, Waukesha, WI, USA) performed the echocardiography examination on a convenience sample of 66 subjects between December 2018 and February 2019 (see sample details in supplementary Table 1). The SVC view was optimal in 77% of subjects, allowing complete M-mode trace during the respiratory cycle; partial in 12%; and not obtainable in 11% of subjects. Compared to subjects with an obtainable view of the SVC, subjects with partial or unobtainable SVC views had significantly lower body-mass index and higher prevalence of chronic obstructive lung disease (supplementary Table 2). Respirophasic variation of the SVC diameter was compared in 16 patients using TTE and TEE imaging with significant correlation between the two measurement methods ($p < 0.001$, $r^2 = 0.9425$); the Bland–Altman plot is depicted in supplementary Figure 1.

We report that it is feasible using TTE to identify the SVC in its longitudinal axis. This allowed the measurement of respirophasic variation of SVC diameter with good correlation to results determined with TEE. This study is single-operator/single-center in design and does

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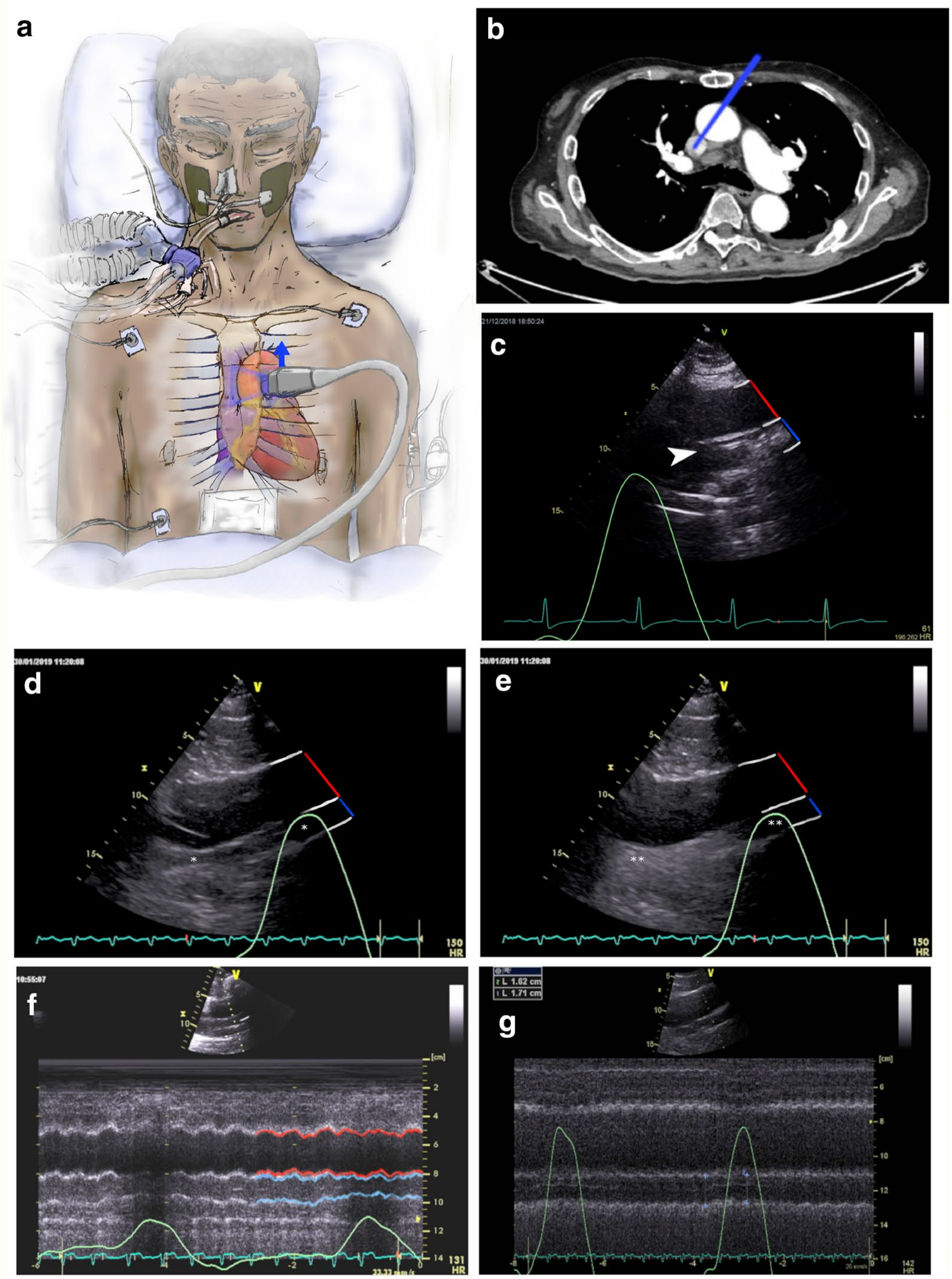

Fig. 1 Transthoracic echocardiography of the superior vena cava. **a** Diagram of probe position required for identification of the superior vena cava (SVC). **b** Chest computerized tomography showing orientation of the image plane required for identification of the SVC. **c** Visualization of a central venous catheter positioned in the SVC (*white arrow*) with the aorta indicated by a *red line*, the SVC by a *blue line*, and the vessel walls highlighted with *white lines*. **d** Visualization of the SVC and aorta without agitated saline contrast injection with the SVC and aorta indicated as in (**c**) and the SVC indicated by an *asterisk*. **e** Identical view of the SVC and aorta as in (**d**) following injection of agitated contrast injection resulting in opacification of the SVC. **f** M-mode visualization of the SVC demonstrating significant respirophasic diameter variation with the SVC *outlined in blue* and the aorta in *red*. **g** M-mode visualization of the SVC demonstrating minimal respirophasic diameter variation

not report the correlation of TTE with TEE in a systematic manner, so it is a hypothesis-generating pilot study. It does offer the possibility of imaging the SVC for purposes of the determination of volume responsiveness without the need to use TEE. This has implications for resource-limited practice environments.

Electronic supplementary material
The online version of this article (https://doi.org/10.1007/s00134-019-05621-1) contains supplementary material, which is available to authorized users.

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Compliance with ethical standards

Conflicts of interest
The authors have no financial or academic conflict of interest regarding this publication.

Ethical standards
This evaluation was performed as a subpart of a larger echocardiographic study which received ethic committee approval.

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