

# Transhepatic right heart ultrasound for central venous catheter tip location in patients with difficult acoustic windows

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Suboptimal central catheter tip location can produce complications such as catheter dysfunction, thrombosis, and vein erosion.<sup>1-3</sup> This can be explained by recalling that venous structures are thin and fragile, making them extremely prone to iatrogenic injury. Adequate catheter tip placement has shown to decrease thrombotic complications and malfunctioning, while increasing catheter life span<sup>1</sup>. Currently, there are various real time catheter tip location methods, such as transthoracic echocardiography (TTE), transesophageal echocardiography (TEE), fluoroscopy, and intracavitary electrocardiography (IC-ECG).

IC-ECG has been used successfully for its advantages and low cost, however this method has certain limitations as its applicability seems to be most reliable in patients in whom basal ECG shows a normal p-wave. Patients with atrial fibrillation, supraventricular tachycardia, mechanical valves, pulmonary heart disease, pacemakers and post-surgical changes may need echocardiography confirmation as an alternative or in addition to IC-ECG to ensure adequate positioning.<sup>4</sup> Recently, Calabrese et al. described a modified IC-ECG method in patients with atrial fibrillation (AF) showing its successful application in this patient population.<sup>5</sup>

Although fluoroscopy and TEE are precise and traditional methods for tip location in the setting of interventional radiology and cardiac anesthesia, they may boast different limitations such as accessibility, costs, operator dependence as well as the need to irradiate the patient with fluoroscopy. Therefore, TTE is a good bedside alternative and is widely used when other techniques are not accessible.

The subcostal view, followed by the four-chamber approach are the preferred methods when positioning the tip near the lower one-third of the superior vena cava (SVC) near the junction with the right atrium (cavo-atrial junction).<sup>6</sup> The above view along with the bubble test can help the operator confirm tip location. The bubble test creates microbubbles that produce a contrast effect, and their

appearance in the right atrium (RA) facilitates the indirect visualization of the tip. If the tip is correctly positioned in the lower third of the SVC, the immediate appearance of the bubbles in the RA will confirm the proximity of the tip. If the bubbles do not appear or appear with a significant delay then the tip is not in the SVC.<sup>1,2</sup> Of note, patient-specific factors may sometimes limit appropriate subcostal windows (barrel chest, subcutaneous emphysema, open abdomen) requiring the operator to shift to alternative views.

Transhepatic intercostal ultrasound view has been documented for cardiac catheterization in the pediatric population,<sup>3</sup> and recently for optimized cardiac imaging in patients with left ventricular assistance devices.<sup>7</sup> To obtain this view, the operator places the sectorial transducer in the midaxillary line between the fifth and seventh intercostal spaces. The initial approach allows the identification of the diaphragm and the right liver lobe; with subsequent anterior sliding and tilting of the probe while following the trajectory of the inferior vena cava (IVC), the identification of the entrance to the RA can be reached. This ultrasound approach allows the identification of a bicaval and RA image using the liver's density to

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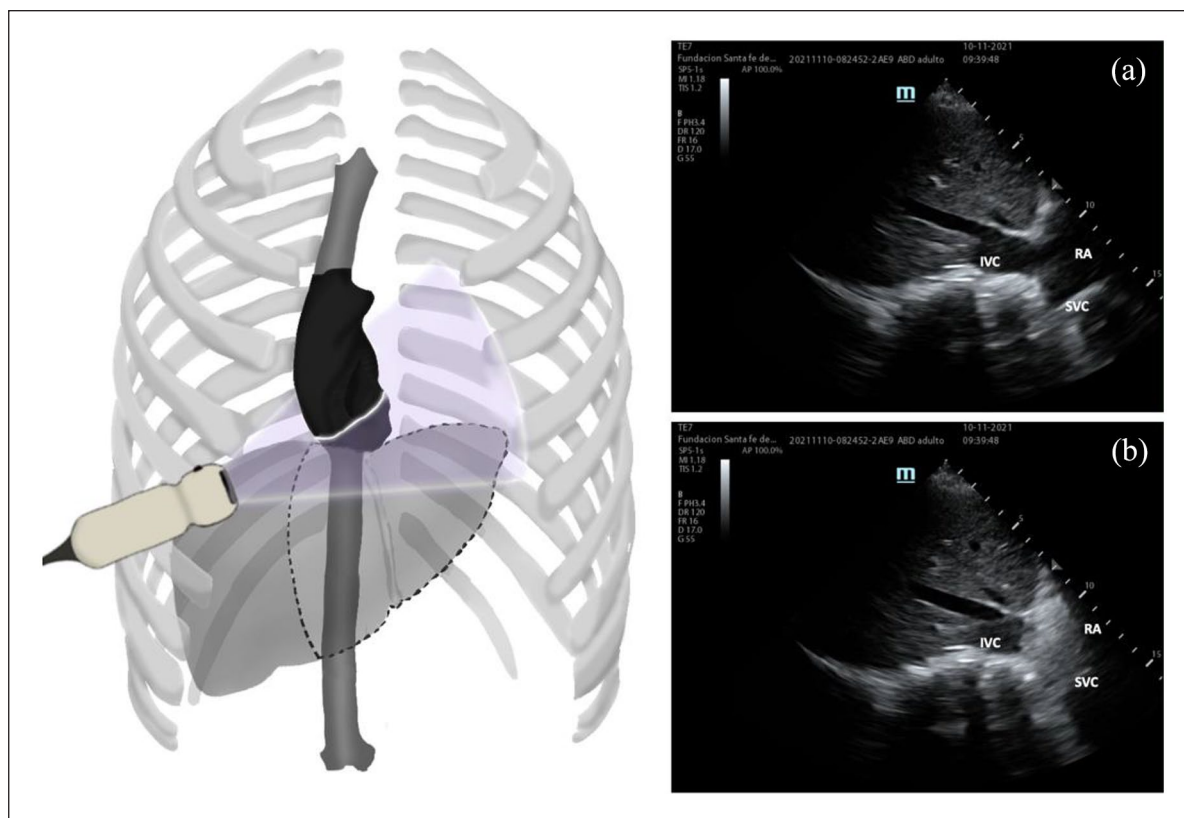
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**Figure 1.** Transhepatic right heart ultrasound. (a) Visualization of inferior and superior vena cava (IVC, SVC) and right atrium (RA). (b) Evaluation of atrial microbubbles contrast with the bubble Test.

enhance the cavoatrial acoustic image.<sup>8</sup> Accurate wire tracing from the SVC to the RA and the bubble test can be comfortably performed, allowing atrial microbubbles contrast identification (Figure 1).

Transhepatic intercostal ultrasound view serves as an additional approach for this purpose and should be strongly considered alone or in addition with other acoustic windows and other catheter tip location methods. Procedural knowledge regarding this view provides an additional assessment which in turn allows dynamic, accessible and trustworthy placement of catheters tips. Limitations regarding the necessity of a second operator, sectorial probe availability and operator learning curve should be considered in advance.

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### Author contributions

All authors (WF, VM, RV, and SA) contributed equally in the conception of the idea, execution and final revision of manuscript. WF and VM performed ultrasound and performed central venous access procedure.

### Consent to for publication

The patient signed the institutional informed consent for clinical history and images use for investigations propose (Available upon request)

### Data availability statement

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study

### Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Ethical approval

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