

SUPPLEMENTARY MATERIAL

Could internal jugular vein ultrasound be useful in the assessment of patients with heart failure? A systematic review

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Method to detect internal jugular vein

Unfortunately, there is no standard method to detect the internal jugular vein (IJV), but many protocols have been suggested by previous reports to assess intravascular volume status.

In particular, many neck and head inclinations have been proposed (Table S1): 0°, 30°, 45°, 60°.

Furthermore, many acoustic views at the apex of the right sternocleidomastoid muscle, cricoid and supraclavicular; similarly, several neck sides: right and/or left.

In any case, many researchers used a high frequency (5-10 MHz, linear array) linear transducer, lightly placed on the neck in a transverse plane over the IJV.

The IJV changes its size during the respiratory cycle: it enlarges in expiration and reduces in inspiration.

Usually, the expiratory (maximum) diameters and area have been used by researchers to test the IJV-US accuracy in predicting diagnosis and prognosis.

Using a B-mode cine loop is possible to obtain the main ultrasound measurements of IJV: anterior-posterior of IJV, AP-IJV, and the transverse diameter of IJV, LL-IJV (Figures S1, S2). By using the previous measurements, the clinician could obtain the derived measurements: Aspect ratio (derived by the formula: AP-IJV max (anterior-posterior maximum diameter)/LL-IJV max (lateral-lateral maximum diameter) (Figures S1-3).

In Figure S4, the maximum, expiratory, cross-sectional area of IJV (CSA-IJV max) is shown.

The collapsibility index (using the M-mode) is derived from the formula: $[(\text{max diameter} - \text{min diameter}) / (\text{max diameter})] \times 100\%$ (Figure S5).

According to the literature, a low value of the collapsibility index (lower than 50%) suggests high central venous pressure (CVP).

During the Valsalva maneuver, the IJV size expands (Figures S6, S7).

The ratio between the maximal diameter after the Valsalva maneuver to that at rest (at the end of the expiratory phase) is called the jugular vein diameter ratio (Figures S6, S7). The IJV meniscus is the point at which the vein collapses in the neck. The vertical height of the IJV meniscus obtained by using either the transverse or longitudinal ultrasound views and by measuring from the sternal notch, after adding 5 cm, should match the CVP (Figure S9).

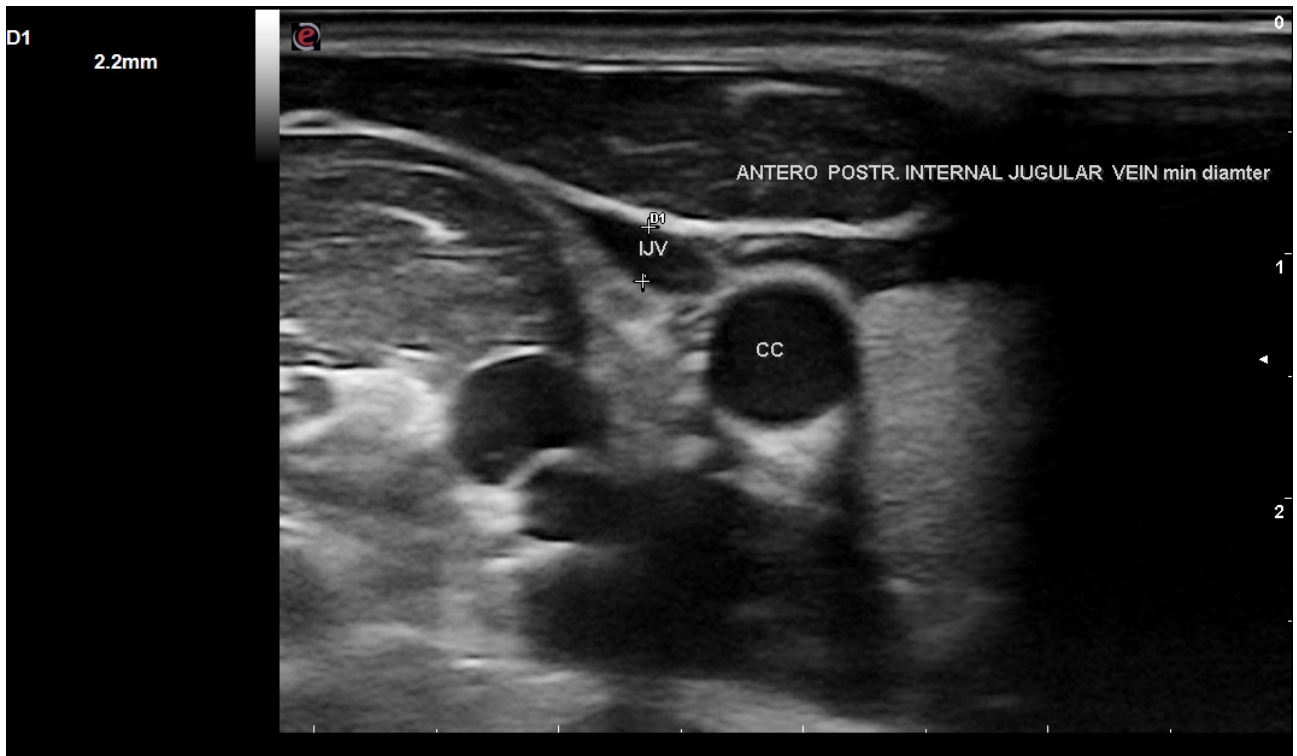


Figure S1. The minimum anterior-posterior diameter of internal jugular vein (D1= antero-posterior-internal jugular vein minimum). IJV, internal jugular vein; CC, common carotid artery.

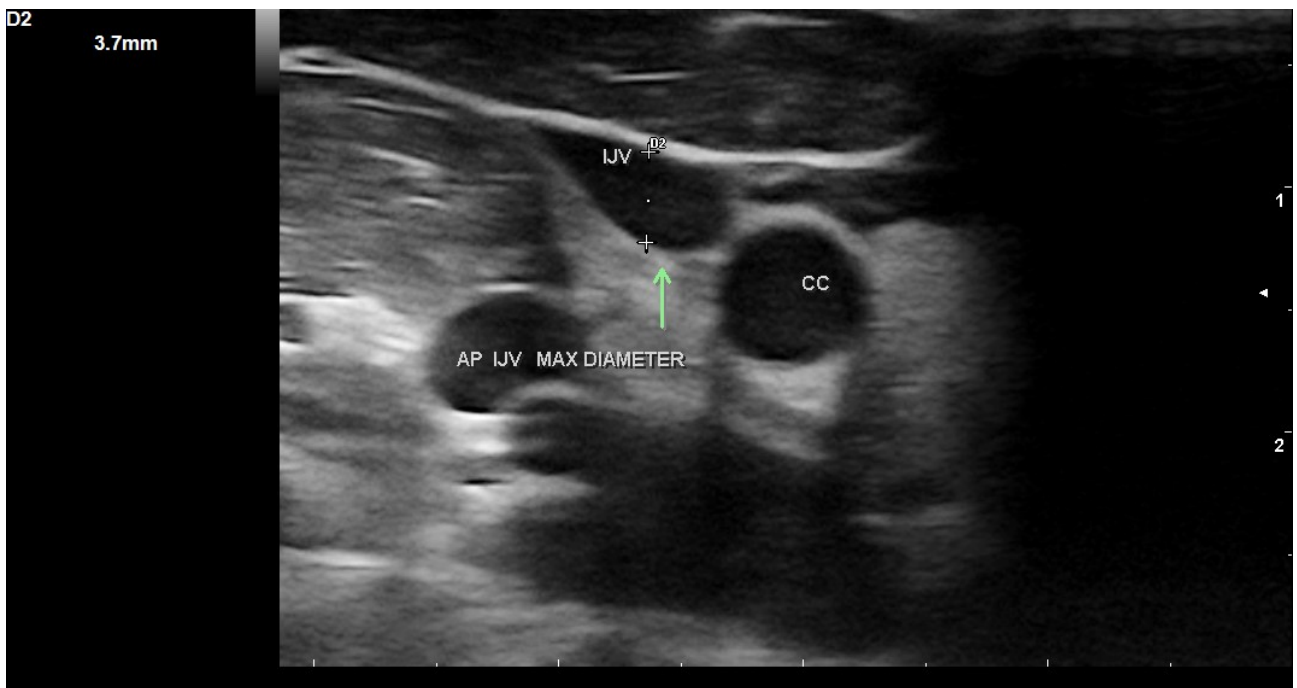


Figure S2. The maximum anterior-posterior diameter of internal jugular vein (D2= antero-posterior-internal jugular vein max diameter). IJV, internal jugular vein; CC, common carotid artery.

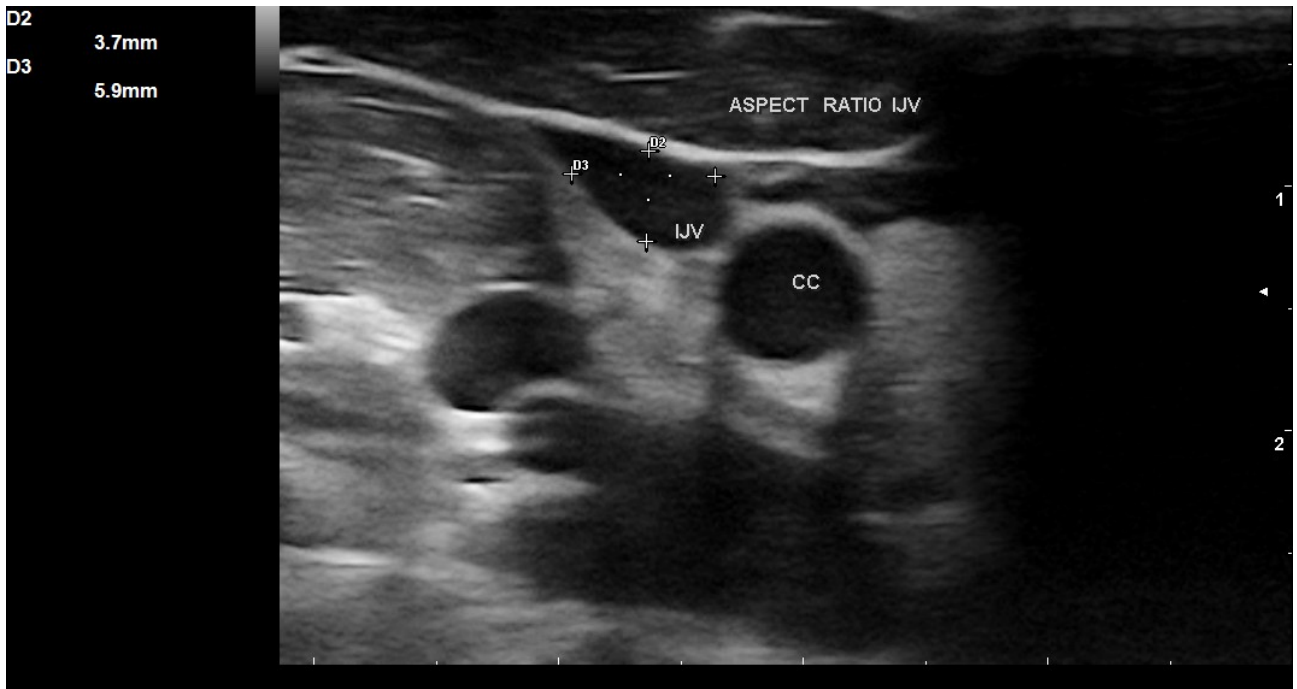


Figure S3. Aspect ratio of internal jugular vein. Aspect ratio, antero-posterior-internal jugular vein maximum diameter (D2)/lateral – internal jugular vein max diameter (D3). IJV, internal jugular vein; CC, common carotid artery.

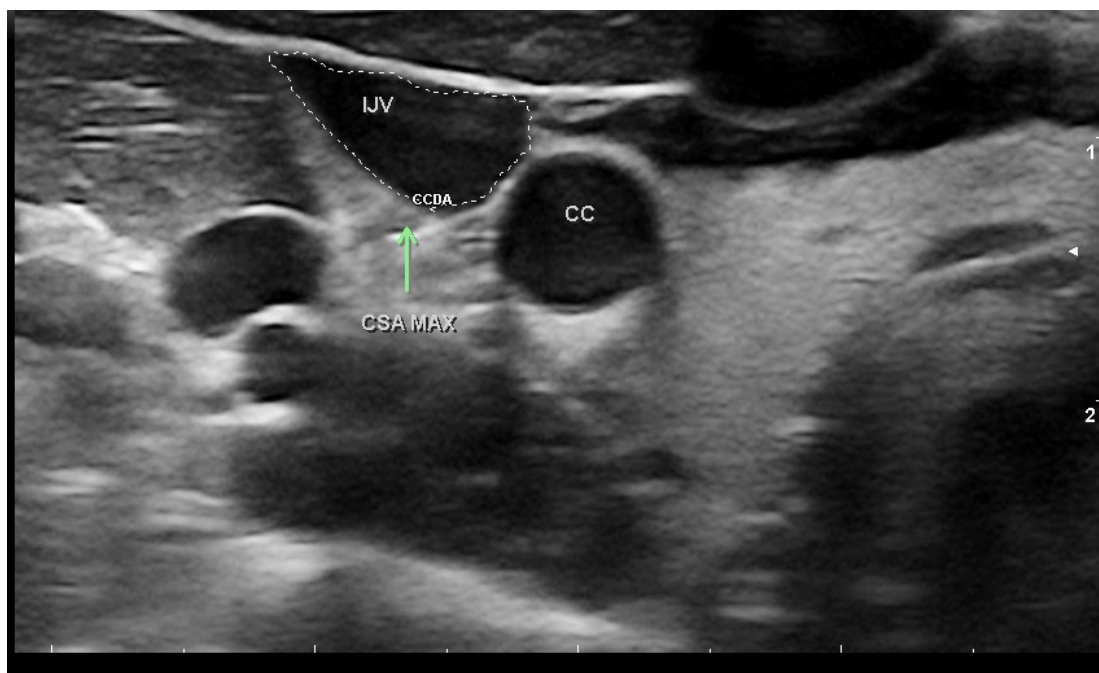


Figure S4. The maximum area of internal jugular vein (cross-sectional area-internal jugular vein max), in the expiratory phase. IJV, internal jugular vein; CC, common carotid artery.

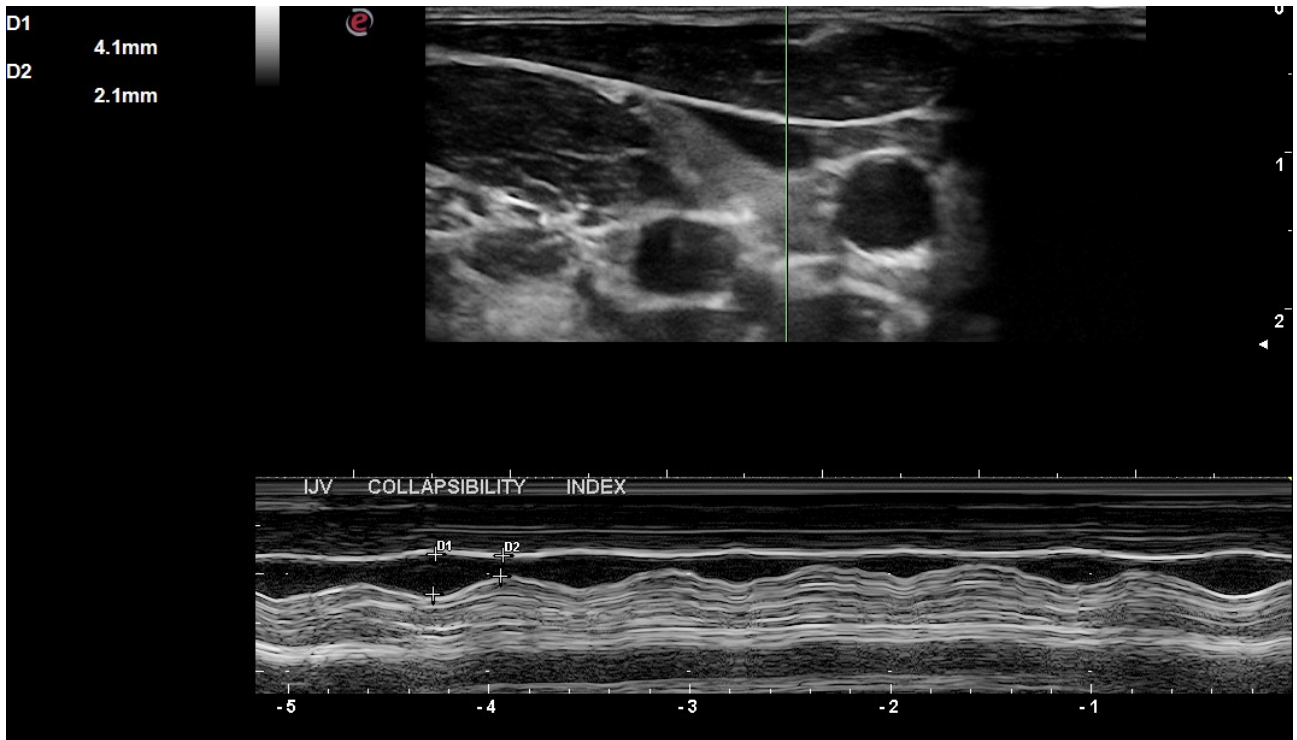


Figure S5. The collapsibility index (using the M-mode), derived by the formula: $[(\text{max diameter, D1 in figure} - \text{min diameter, D2 in figure}) / (\text{max diameter, D1 in figure})] \times 100\%$.

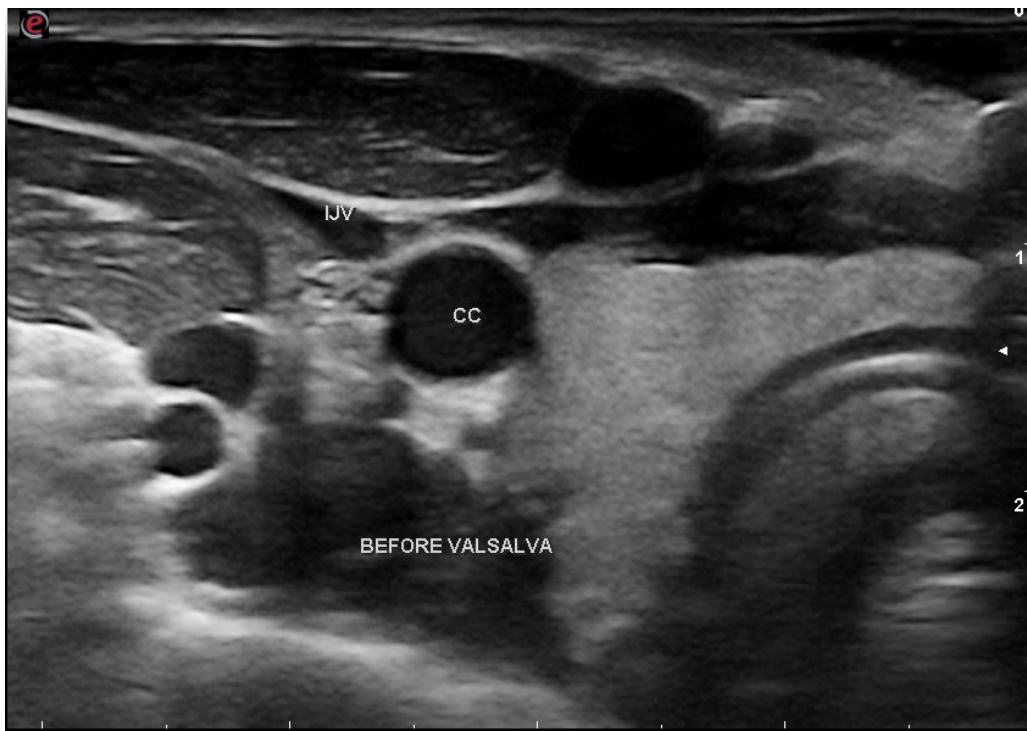


Figure S6. Internal jugular vein before Valsalva. IJV, internal jugular vein; CC, common carotid artery.

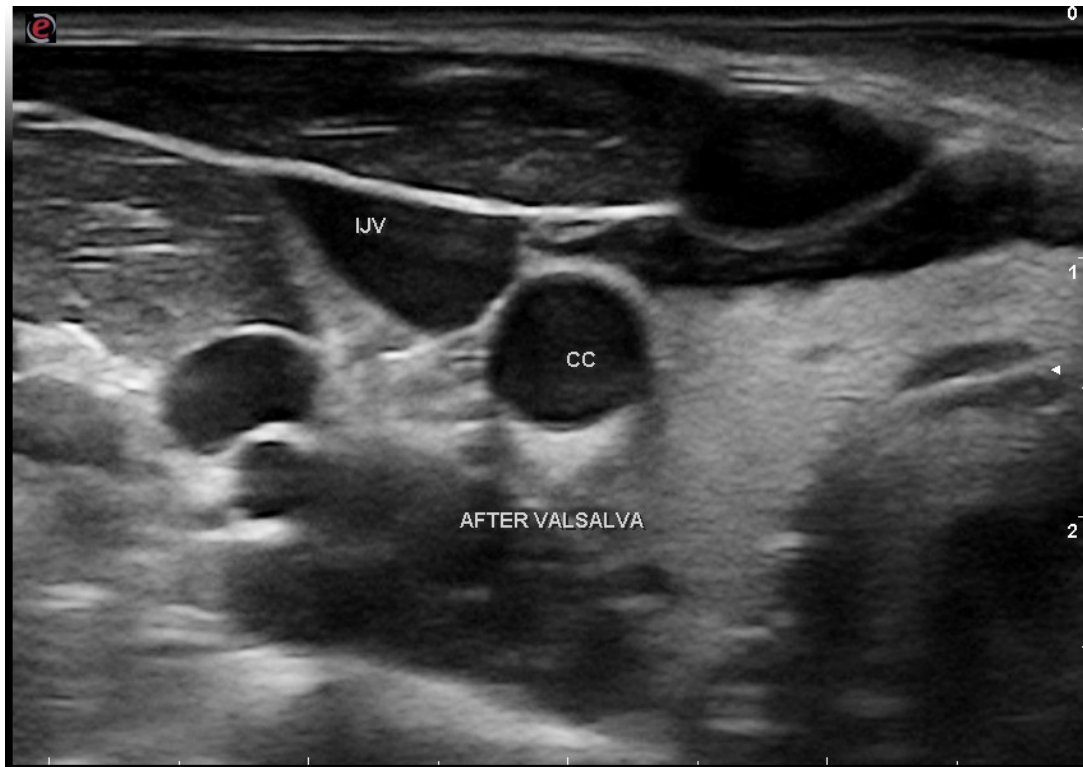


Figure S7. Internal jugular vein after Valsalva. The internal jugular vein ratio derived from the formula: antero-posterior maximum internal jugular vein diameter after Valsalva (antero-posterior-IJV max post-Valsalva)/antero-posterior maximum internal jugular vein diameter at rest, before Valsalva (antero-posterior-internal jugular vein max pre-Valsalva). Internal jugular vein ratio values less than 2 suggest that the patients could have high central venous pressure. IJV, internal jugular vein; CC, common carotid artery.

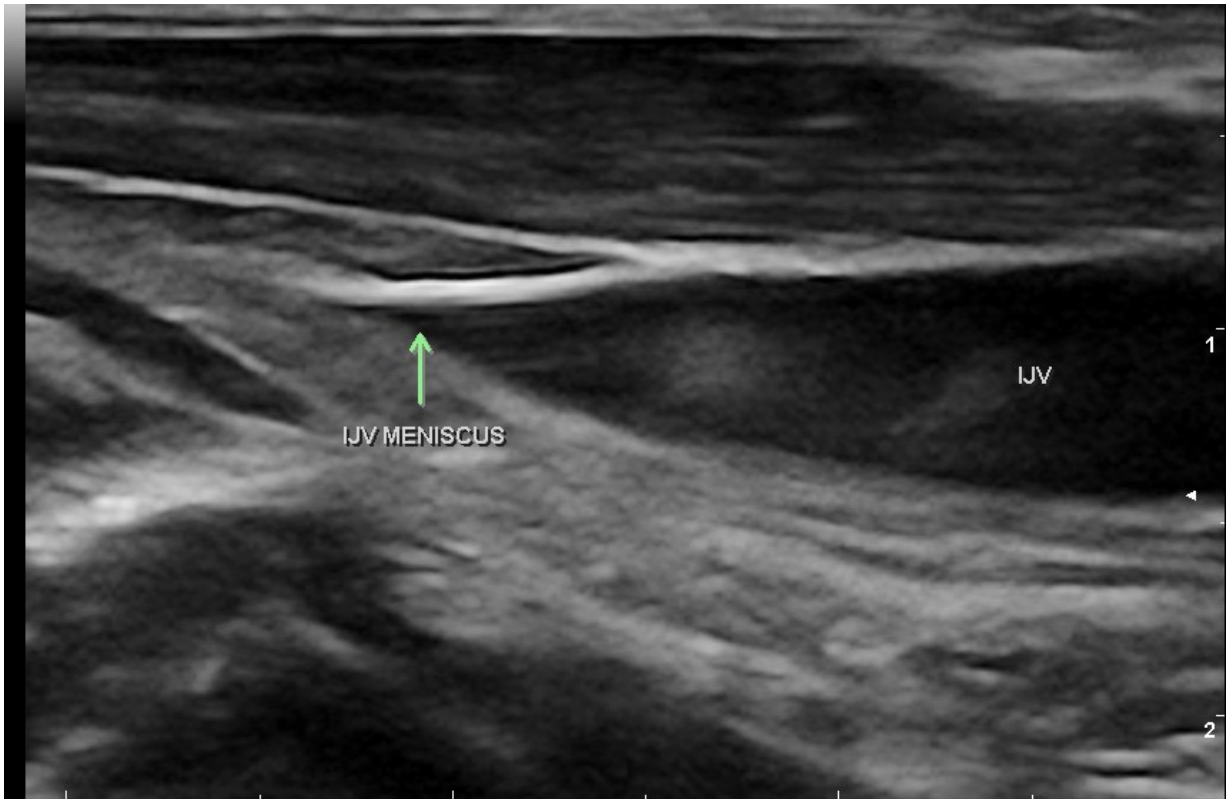


Figure S8. The internal jugular vein meniscus is the point at which the vein collapses in the neck. IJV, internal jugular vein.

Table S1. Comparison of side, view and decubitus of internal jugular vein ultrasound measures among studies collected.

	Ultrasound measure	Side (right, left)	Decubitus	View
Simon <i>et al.</i> , 2018	CSA-IJV max	Right	45°	Apex of the right sternocleidomastoid muscle
Simon <i>et al.</i> , 2010	CSA-IJVmax	Right	45°	Apex of the right sternocleidomastoid muscle
Jang <i>et al.</i> , 2011, Am J Em Med	Height IJV	Not specified	45°	Not specified
Jang <i>et al.</i> , 2011, Eur J Em Med	Height IJV	Not specified	45°	Not specified
Pellicori <i>et al.</i> , 2015	IJV ratio	Left	45°	Apex of the right sternocleidomastoid muscle
Pellicori <i>et al.</i> , 2014	IJV ratio	Left	45°	Apex of the right sternocleidomastoid muscle
Pellicori <i>et al.</i> , 2019	IJV ratio	Left	45°	Apex of the right sternocleidomastoid muscle
Tazadok <i>et al.</i> , 2018	CSA-IJV max	Not specified	60°	Supraclavicular
Vaidya <i>et al.</i> , 2021	AP-IJV max and IJV-c	Right and or left	0°	Apex of the right sternocleidomastoid muscle
Ammirati <i>et al.</i> , 2024	IJV ratio	Right	30°	Apex of the right sternocleidomastoid muscle
Albaeni <i>et al.</i> , 2022	AP-IJV max IJV collapsibil. (B-mode)	Right	0°	Supraclavicular

CSA, cross-sectional area; IJV, internal jugular vein; AP, antero-posterior.