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CORRESPONDENCE

A novel systematic *ABC* approach to *D*iaphragmatic *E*valuation (ABCDE)

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To the Editor,

Because of its easy accessibility and lack of radiation exposure, ultrasonography (US) is an increasingly popular method for detecting hemidiaphragmatic paralysis. Ultrasound can be used to estimate diaphragmatic displacement and contraction by M-mode scanning the zone of apposition through hepatic and splenic acoustic windows (Figure). A linear relation exists between inspiratory or expiratory volumes and movement of the cephalic margin of the zone of apposition.[1] In regional anesthesia practice, scanning the zone of apposition has been used to evaluate hemidiaphragmatic paralysis following interscalene brachial plexus blockade.[2] This method can be challenging, however, because it is often difficult to obtain an adequate acoustic window, especially on the left (splenic) side. Other studies have shown that diaphragmatic function can be evaluated effectively simply by observing diaphragmatic thickening using US during the respiratory process.[3] Unfortunately, many anesthesiologists may not be familiar with this method of locating the diaphragm and so do not perform this helpful clinical evaluation.

Experience with US-guided regional anesthesia suggests that a systematic approach using readily identifiable landmarks can be valuable for facilitating an effective block. Using a similar systematic approach, we offer a simple method for consistently and readily identifying diaphragmatic muscle thickening using B-mode US. Our *ABC* *D*iaphragm *E*valuation (ABCDE) approach involves first placing a high-frequency, linear US probe (e.g., 10-15 MHz) at the anterior *a*xillary line just below the level of the nipple (Figure). One can observe recognizable landmarks between the two ribs, such as movement of the pleura (lung sliding) on top of the diaphragm muscle during *b*reathing. By moving the probe in a *c*audal direction along the axillary line, one can identify *d*iaphragmatic muscle thickening for *e*valuations caudal to the pleural line because the diaphragm is no longer hidden under the pleura during inspiration (see Video 1: spleen side and Video 2: liver side).

Several distinct features are evident when using this ABCDE method with the US probe in the longitudinal plane. First, the image of the pleural edge moves caudally during normal respiration. Second, the pleura can be visualized as it slides just above the diaphragm, helping to distinguish the diaphragmatic muscle from the intercostal muscles. Lastly, diaphragmatic thickening can be observed just inferior to the edge of the pleura as the scan moves caudally. Seeking specific acoustic windows of the liver or spleen, which is often difficult, is thus unnecessary. Indeed, the success rate with the ABCDE method is the same on each side because the diaphragm is assessed directly via the intercostal space, without requiring the liver or spleen for US windows (see attached videos as Electronic Supplementary Material).

It is important to note that pleural (i.e., lung) movement does not guarantee spontaneous diaphragmatic contraction and movement. This is because pleural motion can be generated by paradoxical movement caused by the contralateral lung and diaphragm. Moreover, the change

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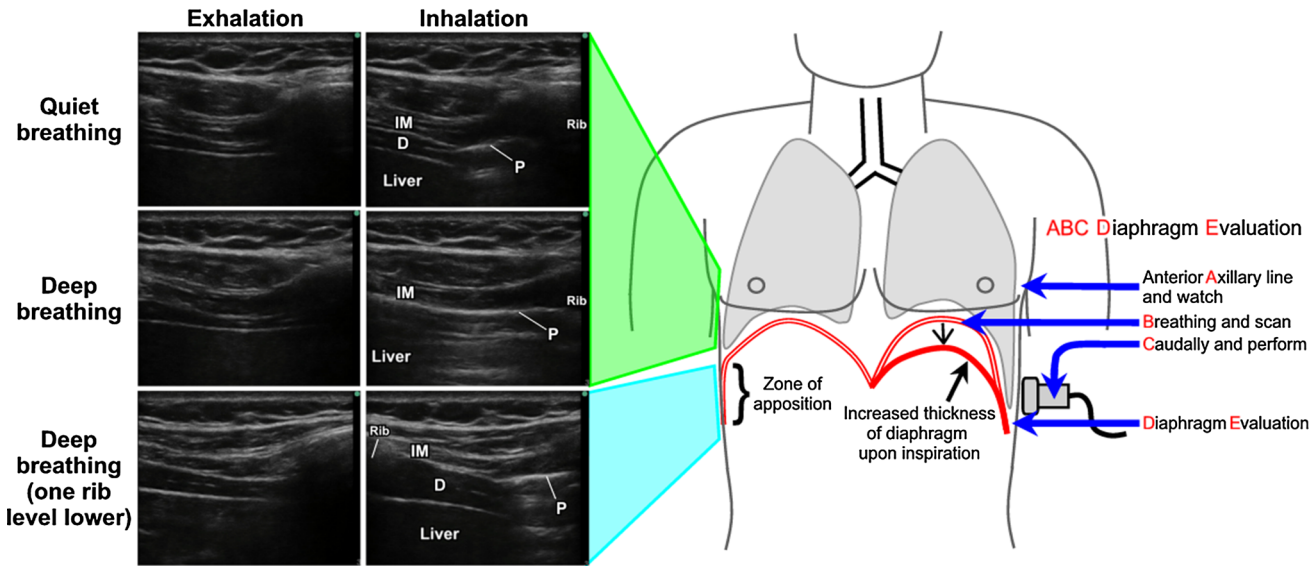

Figure *Left*, ultrasound images showing movement of pleura (P) upon breathing with the ultrasound probe placed at the anterior axillary line just below the nipple level (*top and middle rows*). At this level, the diaphragm can be visualized upon inhalation with quiet breathing; however, with deep breathing, the diaphragm is obscured completely by the pleura. After moving the probe caudally, approximately to the zone of apposition, diaphragm thickening (D) can be visualized (*bottom row*) even upon deep inhalation. IM = intercostal muscle. *Right*, schematic showing anatomic landmarks and probe movement used in the ABC Diaphragm Evaluation method

in the diaphragm thickening ratio [thickness at inspiration − thickness at expiration]/thickness at expiration) reflects muscle effort (28-96% change in healthy individuals *vs* −35% to 5% change in those with diaphragmatic paralysis).[4,5]

In summary, we believe that this novel *ABC D*iaphragm *E*valuation approach may help anesthesiologists easily and quickly learn and remember how to identify the diaphragmatic muscle using US for rapid clinical diagnosis and monitoring.

Conflicts of interest None declared.

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