Can J Anesth/J Can Anesth (2017) 64:550–551
DOI 10.1007/s12630-017-0844-x

IN REPLY

In reply: Proper use and interpretation of diaphragmatic ultrasonography

Kariem El-Boghdadly, MBBS · Alberto Goffi, MD · Vincent Chan, MD

Received: 2 February 2017 / Accepted: 9 February 2017 / Published online: 17 February 2017

To the Editor,

We are grateful to Dr. Sondekoppam *et al.*[1] for their dialogue relating to our recently proposed method that aims to simplify diaphragmatic ultrasonography for detecting phrenic nerve palsy by tracking gross pleural movement.[2] Although promising in our preliminary experience, we caution that this method must undergo validation against well-established diaphragmatic excursion measurements. Similar to the ABCDE approach with a sniff test,[3] our method also interrogates the diaphragmatic zone of apposition and the adjacent pleura. Unlike the ABCDE approach, however, which measures the change in diaphragmatic muscle thickness on B- and M-mode sonograms, we simply measure a change in the pleural line position on the skin surface from full expiration to full inspiration. Another distinction we emphasize is recognition of the sonographic appearances of the rib, pleural line, diaphragm, and visceral organs (liver or spleen) as critical for identifying the direction of probe movement, independent of the initial probe position. For example, if the initial scan is too caudal (i.e. showing the diaphragm and spleen), the next logical step is to move the probe cephalad, and vice versa.

Our scanning approach is therefore based on "sonoanatomical" observations to identify an "ideal site" to start scanning, and not a palatable mnemonic aid (ABCDE approach).[3] The value of our technique lies in assessing pleural movement before and after performing a block to detect diaphragmatic paresis. Thus, patients act as their own controls, allowing comparison of *changes* in excursion. This approach should theoretically reduce the risk of false negatives reported with other techniques, including studies cited by Sondekoppam *et al.*[1]

Diaphragmatic thickness and excursion measurements are well-established, validated methods for assessing diaphragmatic function in spontaneously ventilating patients.[4] Thus, the two recently described methods are not entirely "new" as both represent simplified versions of existing methods.

Sondekoppam *et al.* questioned our assessment of diaphragmatic function based on the extent of pleural movement. Although we make no claim that lung volume assessment is accurate with our method, displacement of the diaphragm at the level of the zone of apposition correlates well with contraction,[5] as elegantly demonstrated in the figure provided by Naik *et al.*[3] Hence, regional anesthesia studies assessing diaphragmatic paresis routinely use this concept to diagnose phrenic nerve palsy.[6] Additionally, although tidal volume breathing utilizes multiple muscle groups, the diaphragm is the primary driver. Thus, the well-known phenomenon of diaphragmatic displacement translates to movement of the adherent pleura, particularly at the caudal extremes – the ultimate goal of diaphragmatic contraction. In the presence of either acute or chronic complete paralysis, excursion might be absent, and partial paralysis might be accompanied by reduced excursion.[4] The latter, however, may be associated with some diaphragmatic (ergo pleural) movement, as might have been demonstrated by the figure provided by Sondekoppam *et al.*[7] The same principles hold true for diaphragmatic thickness assessment. Indeed, a minimal change in muscular

K. El-Boghdadly, MBBS (✉)
Guy's & St Thomas' NHS Foundation Trust, London, UK
e-mail: elboghdadly@gmail.com

A. Goffi, MD · V. Chan, MD
Toronto Western Hospital, Toronto, ON, Canada

thickness with respiration might be present in normal individuals, and a significant change in thickness may be seen in those with diaphragmatic paralysis.[8] There is also evidence suggesting that diaphragmatic thickness might not change with lung volumes in a linear fashion, whereas the thickness increases significantly between apnea and 10% inspiratory effort.[7] Ultimately, both techniques have advantages and limitations.

Given the dearth of high-quality, objective clinical research data in this area, we reserve judgement regarding the ease of performance and reliability of either diaphragmatic ultrasonography technique at this early stage of investigation. Our technique is simply an alternative approach that we believe may be easier to perform without the need for scanning through the hepatic and splenic acoustic windows. In addition, superficial pleural movement can be observed with a linear probe. We believe that constructive discourse will lead to improvement in its diagnostic simplicity and precision.

Conflicts of interest None declared.

Editorial responsibility This submission was handled by Dr. Hilary P. Grocott, Editor-in-Chief, *Canadian Journal of Anesthesia.*

Financial sources supporting the work None.

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