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# Can Diaphragmatic Ultrasound Become a New Application for Point-of-Care Ultrasound in Preterm Infants?

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The diaphragm is the main muscle involved in respiration, along with the abdominal, intercostal, and accessory muscles. It is a tendomuscular structure that rises centrally in the lumbar vertebrae from L2 to L4 and extends laterally toward the rib cage, where it creates the zone of apposition of both hemithoraxes (between the eighth and ninth intercostal spaces), thus limiting the thoracic and abdominal cavities.

As the use of point-of-care ultrasound has spread as a new complementary tool for critical and noncritical patient evaluation, diaphragmatic ultrasound (DU) recently began being used to assess both diaphragmatic anatomy and function with a similar purpose: recent research in pediatric care settings has focused on its relationship with extubation success[1] and on diaphragm dysfunction in critically ill patients.[2]

This technique can be performed from a subcostal or lateral view[3]: the former is used to visualize each diaphragmatic dome and their excursion on the sagittal plane (diaphragmatic excursion [DE]), and the latter is used to measure the inspiratory and expiratory thickness of the diaphragm in the zone of apposition, allowing us to assess the percentage that the diaphragm thickens during each respiration (ie, the diaphragm thickening fraction [DTF]). Patients with a lower DTF are at higher risk of extubation failure, and the decrease in diaphragm thickness after some time on mechanical ventilation has been used as a diagnostic criterion for diaphragm dysfunction.

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Currently, very little evidence is available of the possible impact of DU in neonatal ICUs, and the article by Yeung and collaborators[4] in this issue of *CHEST* is a very good starting point for this technique. To our knowledge, this is the first study in which the authors evaluate DTF after the first days of life in a neonatal ICU, and they demonstrated that healthy term newborns have a lower DTF and DE than preterm infants (PTIs) with bronchopulmonary dysplasia (BPD) at a similar postmenstrual age. Because DTF is related to a greater work of breathing and respiratory load[5] and DE is the direct movement of the diaphragm, both results seem to be in line with a compensation for the underlying lung disease in these patients. In the same way, a previous article found no difference in DTF between term newborns and PTIs with no respiratory distress[6]; it seems that the difference lies in the respiratory disease, rather than in the prematurity itself.

The logical continuation of this line of research would be to study its relationship with extubation failure in PTI: DU also has been studied to predict extubation failure in PTI after respiratory distress syndrome,[7] but never in those with evolving BPD after the initial phase of surfactant deficiency. However, the main limitations of this examination in PTI are the slower learning curve than with lung ultrasound (LU), as well as lower interobserver agreement between nonexpert and expert examiners resulting from the very small size of the measurements (0.1-0.2 mm).[6] These limitations may reduce the spreading of DU in the tiniest PTIs because they need to be handled very carefully and small movements of the patient may affect the recorded measurements.

Another possible application of DU in the neonatal ICU is the study of the relationship of invasive mechanical ventilation with DTF and DE: the study by Yeung and collaborators[4] compared healthy term newborns who never required respiratory support with patients with BPD. Past evidence in adult, pediatric, and animal

settings has shown that even short periods of invasive mechanical ventilation are linked to diaphragm dysfunction and atrophy; however, these results have not yet been replicated in neonates. This is relevant because the diaphragmatic configuration is clearly different in this group from that of adults or older children.[8] Further variables also may be influencing these outcomes: liver surgery in adults[9] has been demonstrated to reduce DTF as well as severe sepsis.[10] Their correlates in PTI, necrotizing enterocolitis, and late-onset sepsis may or may not also have an impact on diaphragm function in this population.

However, as Yeung and collaborators[4] correctly detail in the discussion of their article, the different organs of the respiratory system cannot be evaluated as isolated sections, and the lung also should be taken into consideration when performing DU. We already know that LU is different at the same postmenstrual age in PTIs who demonstrate BPD compared with those who do not[11]: as we read in Yeung and collaborators'[4] study, these differences in diaphragm function can be explained by the differences in LU, so the optimal point-of-care ultrasound approach would include a combination of LU, DU, and probably also echocardiography, as already has been proven in adult settings.[12]

We believe that diaphragm evaluation should be implemented in neonatal ICUs because it is a vital component of the neonatal respiratory system, but we must still wait for more evidence on DU before it is included as a universally available point-of-care ultrasound tool in this population. In the meantime, other noninvasive measurements, such as transcutaneous electromyography[13] and electrical activity of the diaphragm,[14] also are possible new tools that are likely to fill this gap.

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