Transthoracic pulmonary ultrasonography: looking inside the lungs to better treat the dialysis patient

Ultrassonografia pulmonar transtorácica: olhando dentro dos pulmões para melhor tratar o paciente em diálise

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Evaluations of extracellular fluid volume (ECFV) control are among the most difficult assessments of kidney function in nephrological practice, particularly in patients with chronic kidney disease (CKD) who are undergoing dialysis. Traditionally, ECFV estimate is based on the concept of dry weight, which refers as the lowest weight a patient can tolerate without the development of symptoms of hypotension.

The inaccuracy of ECFV estimation as mentioned explains the hypervolemia and hypovolemia observed during hemodialysis, which are associated with undesired clinical consequences. For example, hypervolemia predisposes to lung congestion, volume-dependent hypertension, left ventricular systolic and diastolic dysfunction, and heart failure. Hypovolemia is associated with intradialytic hypotension, loss of vascular access, and worse quality of life. Thus, there is a clear need for more accurate ECFV estimation methods in the treatment of patients undergoing dialysis.

However, so far, there is no definitive scientific basis to justify the use of indicators such as bioimpedance, inferior vena cava (IVC) diameter, plasma volume changes across dialysis by the Crit-Line system, and circulating levels of natriuretic cardiac peptides (ANP, BNP, and proBNP) as biomarkers in the estimation of dry weight.

For example, an assessment of the accuracy of body water measurement using deuterium oxide dilution as a reference indicated that electrical bioimpedance measurements were less accurate in patients with CKD than in healthy individuals.[1] Similarly, IVC diameter does not provide reliable information regarding dry weight.[2] Thus, the urgency associated with developing a more precise clinical protocol that allows for the evaluation and monitoring of ECFV (and lung congestion as a consequence) during hemodialysis treatment is evident.

In the 1990s, ultrasonography (US) began to be used "to see inside" the lung. Because the lungs are filled with air (admittedly, a "great enemy" of ultrasound), the idea of evaluating them using US was unimaginable until 1997, when the French physician Daniel Lichtenstein showed that B-line is an ultrasound sign of pulmonary interstitial water.[3]

B-line is an acoustic artifact generated by the imbalance between air and fluid in the pulmonary parenchyma due alveolar-interstitial "flooding". A B-line is a discrete, laser-like, vertical, hyperechoic images, that arises from the pleural line, extends to the bottom of the screen without fading, moves synchronously with breathing, and erase A-lines. A correlation between the number of B-lines and the accumulation of extravascular pulmonary water was first reported in 2005.[4] However, a study that described the dynamics of the resolution of B-lines in patients treated with hemodialysis aroused interest in the use of lung US in dialysis treatment.[5] In that study, a statistical significant reduction in the number of B-lines over time was observed when pre-dialysis chest US was compared with those obtained at midpoint and after dialysis.

However, it is important to note that B-lines also correlate with several frequently altered cardiac parameters that may determine undesirable clinical outcomes in patients with end stage renal failure. For example, Zoccali *et al.*[6] found that the risks of death and cardiovascular events were 4.2- and 3.2-fold higher, respectively, in patients undergoing hemodialysis who had severe pulmonary congestion identified through B-lines compared with patients with mild to moderate accumulation of lung interstitial water.

In a study published in this issue of JBN, Santos *et al.*[7] evaluated variables associated with pulmonary congestion in 73 prevalent dialysis patients with CKD secondary to diabetes who were undergoing hemodialysis treatment and used B-line count to identify extracellular lung water. In multivariate analysis, the number of B-lines was associated with the IVC collapse index determined by two-dimensional US and with the New York Heart Association (NYHA) score but not with hydration status (measured based on bioimpedance) or the echocardiographic parameters utilized. The correlation between B-line count and diastolic ventricular dysfunction, a frequent comorbidity in prevalent dialysis patients that is associated with unfavorable outcomes, was not fully evaluated in this study.

As acknowledged by the authors, the cross-sectional nature of this study, the characteristics of the sample, the good cardiac function of the examined patients, and the use of bioimpedance to assess hydration status may explain the disagreement between the results found in this study and those obtained by Zoccali *et al.*[6] It is important to recall that water accumulation in the pulmonary interstitium can also result, in addition to hypervolemia, from left ventricular dysfunction and increased pulmonary permeability.

Continuous monitoring with intrathoracic impedance allows for the identification of pulmonary congestion up to two weeks before a patient with heart failure presents with dyspnea, a clinical marker of abnormal water accumulation in the pulmonary interstitium. Besides, lung crackles and/or leg edema very poorly associate with pulmonary extravascular water in patients with ESRD.

Thus, the use of the simple and easy-to-learn technique such as pulmonary US, used at the bedside by nephrologists for the early diagnosis of hypervolemia, particularly when patients remain asymptomatic, is highly welcomed. In this sense, the article by Santos *et al.*[7] is gladly receive and, along with other published studies, serves as a stimulus for multicenter interventional studies that can definitively support the use of point-of-care pulmonary US in the volume assessment of patients undergoing hemodialysis treatment and thereby contribute to optimizing treatment.

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