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EDITORIAL

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Quantitative CT in ARDS: towards a clinical tool?

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Quantitative analysis of computed tomography (CT) was the tool used for pivotal advancements in the understanding of ALI/ARDS pathophysiology. Early observations in the 1980s suggested that the lung parenchyma of ARDS patients, in contrast with the common belief, was inhomogeneous rather than uniformly affected [1, 2] and the remaining lung available for ventilation was "small" rather than "stiff" [3], leading to the concept of "baby lung" [4]. Further studies elucidated the anatomical mechanism underlying the effect of PEEP, prone position and the inspiratory/expiratory relationship with the CT demonstration of intratidal recruitment [5]. Interestingly most of these studies had been performed with only three or even one CT scan slices, which were sufficient to elucidate the mechanism. The methods applied and results obtained with the one or three slice technique were used and confirmed by many others who used the whole lung CT scan, in particular, where the subdivision of lung into compartments is concerned [6–8]. In fact, it has become a standard method in lung CT analysis to quantitate the lung parenchyma as normally aerated, hyperinflated, poorly inflated and not aerated. Indeed, CT allows a sort of quantitative anatomy "in vivo" and, more important, when repeated in different conditions, such as different inflation pressures, may reveal such phenomena as recruitability, which may be of huge clinical relevance in setting mechanical ventilation. However, although extremely useful in understanding mechanisms and ARDS pathophysiology, the quantitative CT scan technique never became an established method for clinical use. This, despite the fact that the technique may reveal some characteristics of the ARDS lung potentially relevant for therapy. Therefore, we may wonder why such a powerful technique did not achieve widespread use in clinical practice. We believe that this derives from a perceived negative balance between disadvantages associated with the whole lung CT scan, which are certain, compared to benefits which are thought to be only potential. Obvious disadvantages include the discomfort and possible harm of transportation to the CT facility, the cost of the technique, X-ray exposure and the considerable amount of work required to manually segment the CT images to obtain quantitative data. We have used CT scans in ARDS routinely for more than two decades, as we believe that the benefits outweigh the harm. We found that the primary clinical advantage is the definition of lung recruitability by whole lung CT scan [9], which is the prerequisite for establishing PEEP setting [10] and possibly prone position application [11].

Reske et al. [12] described a technique which potentially may decrease two of the disadvantages of CT scan balance, i.e. X-ray exposure and the time required for quantitative analysis, by limiting the CT to ten slices instead of three slices (too few slices) or whole lung analysis (too many slices); we may therefore briefly discuss whether the proposed technique is suitable for routinely clinical application. The authors emphasize the results in terms of number of CT scan slices, however it must be remembered that the amount of lung parenchyma analyzed depends not only on the number of slices but on their thickness. The time needed to manually segment a lung section will be the same, but the amount of lung sampled may be importantly different. Reske et al. used a 5 mm slice thickness in 29% of patients and a 10 mm slice thickness in 71% of patients, and did not find significant differences when comparing the two different thickness with the whole lung CT. This is not surprising when an ARDS population is averaged, due to tremendous variability of the CT findings. When considering a single patient, it must be considered that as the lung is reconstructed, ten slices with 5 mm thickness will include about 22% of the lung tissue, while the same number of slices with 10 mm thickness will include about 44% of the lung. A reconstruction with a slice thickness of 22.6 mm would allow covering the whole lung parenchyma of the studied subjects in 10 slices at the price of a greater number of partial-volume effects. Lowering computed tomography resolution may also allow using a lower potency X-ray beam, slightly reducing radiological exposure. We believe that the routine clinical use of CT in ARDS patients is indicated as early as possible to quantify the lung recruitability, which implies the use of two CTs scanning at two different airway pressures. The estimation of recruitment does not need the observation of fine anatomical details, and so thick slices are suitable for this goal, as well as for computing lung weight and the amount of collapsed/consolidated lung, which cannot be assessed otherwise [9, 13]. We believe that there are clinical arguments which affirm that all these variables may have a role in suggesting/dictating particular therapies in ARDS, such as higher versus lower PEEP or the use of prone position [10, 11]. Therefore, any technique or algorithm which decreases the present disadvantages of CT is most welcome; the Reske paper [12] presents this possibility.

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