Ultrasound evaluation of diaphragm functionality: relationship with standard and imaging approaches.

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Purpose. Diaphragm is the principal respiratory muscle involved in quiet and deep breathing. Similarly to other skeletal muscles it can develop structural and functional modifications in response to specific muscle trainings or as a consequence of severe diseases. Different techniques are available to evaluate diaphragm function. Spirometry, maximal inspiratory and expiratory pressure (MIP and MEP, respectively) and maximal voluntary ventilation (MVV) are standard tests. Ultrasound (US) images have been introduced to determine the amplitude of diaphragm excursion during voluntary breathing as an additional indicator of diaphragm functionality. The neuromuscular aspect is assessed by measuring the compound motor action potential (CMAP) of the diaphragm during phrenic nerve stimulation (PNS). Nowadays, the relationship of US measurements have been investigated with only few traditional indicators. Moreover, no study evaluated the feasibility of US measurement during PNS. Therefore, aim of this study was two-folds: i) to explore the existence of possible correlations between US measures and traditional pulmonary function variables and ii) to evaluate the applicability of a combined US and PNS technique in assessing diaphragmatic function. **Methods.** Twenty-seven healthy students (17 male; age: 23±5yr; body mass: 72±11kg; stature: 1.7±0.1 m, mean±standard deviation, SD) participated to the study. Forced vital capacity (FVC), vital capacity (VC), MVV, MIP and MEP were assessed. The amplitude of diaphragm excursion during deep breathing was also determined (A_DB). During PNS the amplitude of diaphragm excursion (A_PNS) obtained by US were recorded simultaneously with CMAP. Besides the relation with CMAP, associations between US measurements (A_PNS and A_DB) and standard pulmonary tests were determined using Pearson's product moment correlation coefficient (r). **Results.** A_PNS showed a slight correlation with only CMAP ($r = 0.37$; $p=0.05$). A_DB correlates with MVV ($r=0.45$; $p<0.05$) and with MIP ($r=0.38$; $p=0.048$). The correlation with FVC and VC are near to significant values ($p=0.07$ and $p=0.08$, respectively). **Conclusions.** The simultaneous acquisition of US during PNS may provide a mechanical counterpart of the electrical activation of diaphragm. Moreover, US images collection during deep breathing seems to be a valid approach to evaluate diaphragm strength capacity, therefore it could be a convincing indicator to assess changes in diaphragm function.