Non-Invasive Mechanical Ventilation implementation for lung SBRT: Workflow validation on healthy volunteers

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Résumé

Introduction: Non-Invasive Mechanical Ventilation (NIMV) is an optional motion management strategy in RT which constrains respiration using a mechanical ventilator (Van Oooteghem et al., *Rad.Onc.*, 2019). With appropriate parameters, NIMV induces either regular and reproducible breathing (volume-controlled mode – VNI-ST) or repeated breath-holds (slow-controlled mode – APRV). This technique implying the collaboration of different stakeholders will be applied for lung SBRT patients in our department later this year. To ensure safety of the process, we developed a dedicated workflow (WF) to adjust methodology and organizational parameters and validate each step on healthy volunteers.
Material and Methods: The dedicated WF consists in three major steps enrolling 10 healthy volunteers. First, a training session with a physiotherapist is used to introduce the volunteer to NIMV and to select appropriate equipment (mask and tubing). The ventilator's parameters are progressively defined with a spontaneous breathing phase followed by VNI-ST mode to finish with APRV mode. During the simulated CT, a RTT applies the previously defined ventilation parameters. A respiratory signal is acquired using a surface imaging system. Finally, a RT session is simulated in the same conditions and a respiratory signal is acquired with another surface imaging system. Additionally, a free-breathing signal is acquired for comparison with those obtained with NIMV. Breathing signals analysis in terms of amplitude, frequency and cycle-to-cycle variability is performed by a Python program (Venkat et al., *Phys.Med.Biol.*, 2008). A questionnaire is provided to the volunteer to collect feedback on their experience (comfort, difficulty encountered, explanations clarity).

Results: The dedicated WF for the first volunteer is detailed in *Fig. 1.* The training session duration necessitated 50 min to ensure volunteer appropriate compliance and understanding of the technique. The simulated CT session was composed of 10 min for setup and free-breathing acquisition and 10 min for NIMV equipment setup and VNI-ST acquisition.

*Intervenant

Analysis of the volunteer respiratory signals using our Python program provided preliminary results (*Fig. 2*) demonstrating the potential of NIMV compared to free breathing, with improved regularity and a higher frequency (13.7 bpm VS 7.3 bpm). However, mean motion amplitude was higher with NIMV (4.5 mm VS 2.3 mm). Based on feedback from the first volunteer, stakeholders decided to propose at least 2 different masks size to avoid air leakage to ensure NIMV efficiency.
Conclusions: Results on the first volunteer showed that NIMV was well tolerated and provided a regular and reproducible breathing. One of the next improvements will be the modification of NIMV parameters to obtain a reduced motion amplitude. A dedicated WF for NIMV implementation is essential for stakeholders to optimize the process and gain in confidence as well as to ensure patients comfort and compliance.

Mots-Clés: Ventilation mécanique non invasive, stéréotaxie pulmonaire, gestion du mouvement, validation du workflow