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Short report

Towards individualised and optimalised positioning of non-ventilated COVID-19 patients: Putting the affected parts of the lung(s) on top?

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ABSTRACT

The outbreak of COVID-19 led to an unprecedented inflow of hospitalised patients with severe acute respiratory syndrome (SARS), requiring high-flow non-invasive oxygenation, if not invasive mechanical ventilation. While the best option in terms of non-invasive systems of oxygen delivery is still a matter of debate, it also remains unclear as to whether or not the optimal in-bed positioning of patients might also help to improve their oxygen saturation levels. On the basis of three representative cases, it is possible to propose the following hypotheses: (i) how patients are positioned has a strong influence on their oxygen saturation levels; (ii) saturation-optimalised positions are patient-specific; (iii) prone positions require ergonomic devices; and (iv) saturation-optimalised positions should aim to place the most affected part(s) of the lung(s) on top. Considered together, these hypotheses have led us to recommend that COVID-19 patients should undergo a specific assessment at admission to determine their saturation-optimalised in-bed position. However, further studies are still needed to assess the benefits of such a strategy on clinical outcomes.

In non-intensive care unit (ICU) wards, the management of patients with COVID-19, the infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), consists mainly of supplying oxygen to prevent desaturation and respiratory exhaustion. While the benefits of prone positioning have been advised for ICU COVID-19 patients receiving invasive mechanical ventilation [1] –even though such benefits may be modest in this atypical acute respiratory distress syndrome (ARDS) [2]– it is still largely not known whether such specific positioning can help non-mechanically ventilated COVID-19 patients to optimally recruit their own respiratory systems. Two previous studies have described the benefits of the prone position (lying face downward) in a small series of patients with hypoxaemic acute respiratory failure [3,4]. In addition, an awake prone position was also mentioned by a Chinese team, as one of three interventions allowing them to reduce the risk of having to escalate the management of COVID-19 patients to invasive mechanical ventilation [5].

In our initial attempt to further explore this question, three patients with polymerase chain reaction (PCR)-confirmed coronavirus SARS-CoV-2 infection were studied to evaluate how their oxygen saturation levels changed according to body positioning. Several different positions were assessed: semi-sitting in bed; sitting in an armchair; lying face upward (supine); lying laterally on the left and on the right; lying prone; and lying prone ergonomically. For this lattermost position, a support device was specifically designed for each patient that essentially consisted of a rectangular piece of foam mattress with a large hole in the middle adapted to abdominal morphology.

Case reports

Patient 1, a 66-year-old man with a body mass index (BMI) of 28.2 kg/m^2, had a previous medical history that included smoking, type 2 diabetes (T2D), high blood pressure and ischaemic cardiopathy treated with a stent in 2015. He had also undergone spinal surgery for a herniated disc and total hip-replacement

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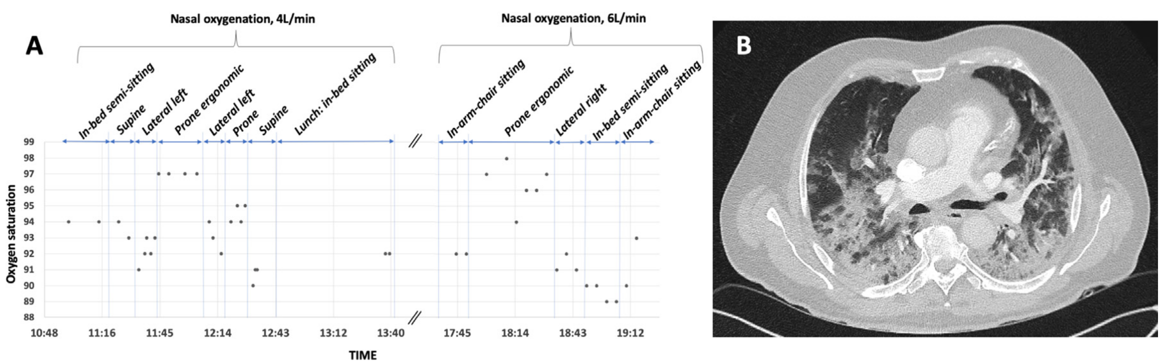

Fig. 1. COVID-19 male patient 1: A. Oxygen saturation levels according to various positions and rates of nasal oxygenation. B. Chest CT scan reveals lung lesions that are predominantly posteriorly located.

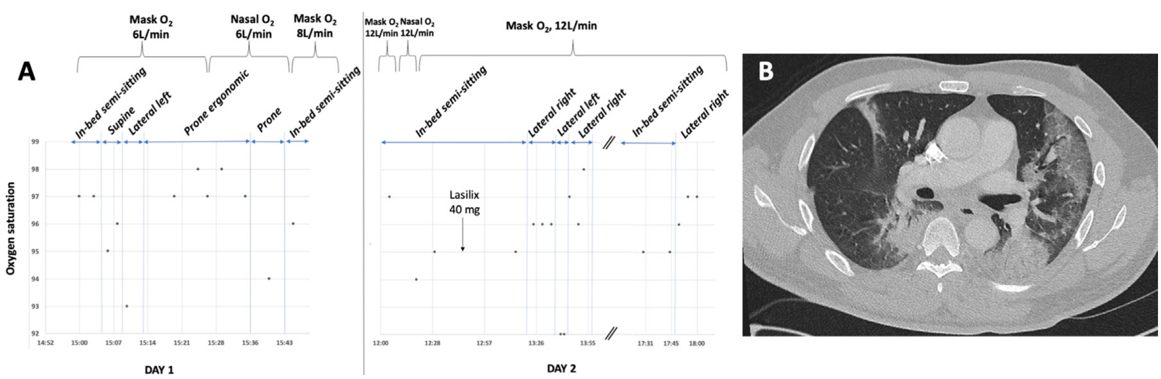

Fig. 2. COVID-19 male patient 2: A. Oxygen saturation levels according to various positions and rates of mask oxygenation. B. Chest CT scan reveals that lung lesions and secondary bacterial infection are predominantly located on the left.

A

	Position	O_2 Saturation
3:40 pm	45° supine	91 %
3:45 pm	seated forward bend	99 %
3:50 pm	45 ° supine	90 %
3:55 pm	lateral right	95 %
4 :05 pm	lateral left	97 %
4 :10 pm	seated forward bend	100 %
4 :25 pm	in-bed sitting	94 %
4 :30 pm	45 ° supine	90 %
4 :35 pm	seated forward bend	99 %

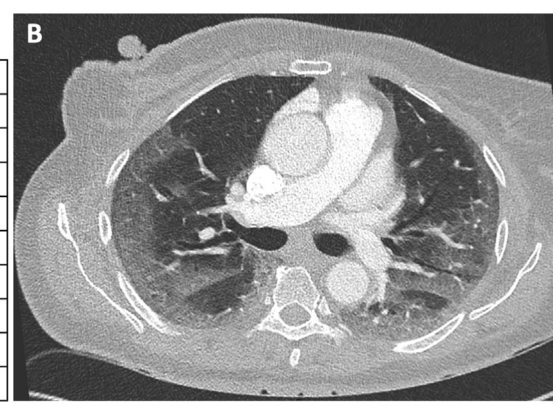

Fig. 3. COVID-19 female patient 3: A. Repeat testing of oxygen saturation levels according to various positions. B. Chest CT scan reveals that her lung lesions are predominantly located posteriorly.

surgery. On 17 March 2020, he developed fever and cough. As he became considerably short of breath, he checked himself into hospital 10 days later on 27 March. On admission to the emergency department, his O_2 saturation level was 77%. With application of a high-flow oxygenation mask (O_2 at 15 L/min), his saturation level increased to 93%. On assessing the patient on 2 April (Fig. 1A), a significant increase in saturation levels was achieved with ergonomic prone positioning. His heart and respiratory rates were also stable (at 97 ± 3/min and 25 ± 2.4/min, respectively). However, due to pain in his back and left hip, the patient was unable to hold this position for more than 30 min. Interestingly, a chest computed tomography (CT) scan (Fig. 1B) demonstrated COVID-19 lesions that were topographically predominantly posterior.

Patient 2, a 46-year-old man (BMI: 27 kg/m^2) with no previous medical history except for vitiligo, experienced his first symptoms (fever and muscle pain) on 24 March 2020. He visited the emergency unit on 29 March because he felt short of breath: his O_2 saturation level was 93%. He was hospitalised and given nasal oxygenation, then evaluated on two consecutive days (2 and 3 April). As with patient 1, the best saturation results were seen with the ergonomic prone position (Fig. 2A). However, moving from supine to prone was unbearable for this patient and, interestingly, while lying in a lateral position on his left side was associated with both a subjective feeling of suffocation and objective desaturation, the right lateral position offered both subjective comfort and saturation levels > 96–97%. His heart and respiratory rates were stable (day 1: 106 ± 4/min and 37 ± 1/min, respectively; day 2: 118 ± 4/min and 37 ± 2.7/min, respectively). Chest CT revealed pulmonary COVID-19 lesions and secondary bacterial infection, all located predominantly on the left side (Fig. 2B).

Patient 3, a 65-year-old woman, had a BMI of 22 kg/m^2, and a medical history of T2D and high blood pressure. She experienced fever and diarrhoea on 24 March 2020, and visited the hospital on 31 March because of the onset of dyspnoea. Her oxygen saturation level on admission was 92%. On assessing this patient on 5 April when seated in bed, her saturation level was 91%, despite a high-flow oxygen mask (at 15 L/min). Her oxygen saturation levels were continuously monitored during each position studied until a time-invariant level was achieved (Fig. 3A). In this patient, both right and left lateral positions correlated with higher saturation levels (95% and 97%, respectively), whereas the prone position could not be tested due to a recent acute, non-traumatic, temporomandibular joint dislocation. However, between each position, this patient spontaneously rested in an unexpected seated forward-bend position, somewhat mimicking a prone position of the trunk; in this posture, her saturation levels reached 100%. This position was then specifically tested twice again, with saturation levels again reaching 99% and 100%, respectively. It should also be noted that these measurements were verified using a second measuring device to exclude any artifactual findings. In all positions, this patient's heart and respiratory rates remained unchanged (76 ± 2/min and 28 ± 1/min, respectively). Chest CT demonstrated severe COVID-19 lesions localised predominantly along the posterior part of the lungs (Fig. 3B).

Future prospectives

Based on our observations from these three cases, it seems most logical to intuitively infer that each patient's optimal positioning should aim to place the most affected part(s) of the lung(s) on top, thereby easing and/or releasing damaged alveolar tissue from the gravity-induced pressure of any surrounding structures. Interestingly, even though the prone position was not the most suitable one for two of our three patients, the ergonomically prone position, using an inexpensive modified mattress support, resulted in the most significant improvement in oxygen saturation levels. This suggests that the design of currently ongoing clinical trials (for example, NCT04325906; see registry at ClinicalTrials.gov) should indubitably consider the ergonomics of positioning and include, in their protocol, any specific supports for such prone positions to avoid the erroneous conclusion that these positions are not effective.

Moreover, our present preliminary results also call for additional studies involving larger samples of patients to properly demonstrate whether each patient's saturation-optimalised position correlates with the particular topography of lung lesions and also whether such a strategy of individualised positioning can reduce the rate of invasive mechanical ventilation. In any case, empirical patient-specific positioning is a costless procedure that could prove to be an essential, yet overlooked, means of optimalising oxygen saturation levels in the SARS-CoV-2 patient population. For this reason, positional assessment should become part of the routine management of these patients. Our present observations also highlight the need to develop ergonomic devices to allow such patients to maintain comfortable saturation-optimalised positions and, in particular, the prone position, which is considerably less comfortable than all the other possible in-bed positions tested.

Disclosure of interest

The authors declare that they have no competing interest.

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