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Prone positioning use to hasten veno-venous ECMO weaning in ARDS

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Electronic supplementary material
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Dear Editor,

A 41-year-old overweight (body mass index 35 kg/m^2) woman was admitted from home to the intensive care unit (ICU) for acute respiratory distress with fever. Her medical history mainly included a neurosarcoidosis treated with corticosteroids, methotrexate and six courses of cyclophosphamide. The computed tomography scan revealed a diffuse alveolar–interstitial syndrome without any mediastinal adenopathy. She received an initial antibiotherapy (cephalosporine, rovamycin) after an examination for infectious diseases. No infectious process or cause for an acute exacerbation of pulmonary sarcoidosis was found in the bronchoalveolar lavage fluid, and antibiotherapy was stopped after 5 days. There was no acute cardiac dysfunction on echocardiography. No diagnosis was made and her respiratory state worsened. She required, after 6 days of evolution, invasive mechanical ventilation to treat an acute respiratory distress syndrome (ARDS).

After 3 days of lung protective ventilation [normal tidal volume (Vt) 5 ml/kg, respiratory rate (RR) 30/min, positive end expiratory pressure (PEEP) 12 cmH_2O, plateau pressure (PP) 30 cmH_2O, static compliance (SC) 20 ml/cmH_2O) with neuromuscular blockade, she remained with a severe ARDS [partial pressure of oxygen in the blood (PaO_2)/fraction of inspired oxygen (FiO_2) 85 mmHg]. Two 24-h sessions of prone positioning failed to improve the PaO_2/FiO_2. No evolutive infectious process was found, and corticosteroids were maintained at 1 mg/kg/day to treat the ARDS inflammatory process. Her respiratory function worsened (Vt 5 ml/kg, RR 35/min, PEEP 10 cmH_2O, PP 30 cmH_2O, SC 20 ml/cmH_2O) with refractory hypoxia on arterial gasometry [FiO_2 100 %, pH 7.45; partial pressure oxygen (PO_2) 75 mmHg; PCO_2 40 mmHg; HCO_3^- 27.5 mmol/l). Consequently, veno-venous extracorporeal membrane oxygenation (vvECMO) was implemented after 7 days of mechanical ventilation despite the absence of a significant pulmonary diagnosis.

After 5 days of vvECMO with ultraprotective ventilation (Vt 2 ml/kg, RR 10/min, PEEP 10 cmH_2O, plateau pressure 22 cmH_2O), respiratory function had not improved. With a FiO_2 of 60 % during ECMO (PaO_2 on the arterial cannula 219 mmHg with an ECMO output of 4.5 l/min) and 100 % on the ventilator, arterial gasometry confirmed the persistent respiratory failure: pH 7.46, PaO_2 82 mmHg, $PaCO_2$ 38.4 mmHg, HCO_3^- 27.5 mmol/l, SaO_2 (oxygenated hemoglobin molecules in arterial blood) 96 %. The cardiac output/blood flow ratio was systematically greater than 70 %. Examination of the chest X-ray revealed an improvement of the initial alveolo-interstitial syndrome with secondary emergence of posterobasal atelectasis. Fiberoptic bronchoscopy aspirations failed to remove these atelectasis. All recruitment maneuvers failed to improve oxygenation, and increasing Vt or PEEP was associated with an unacceptable plateau pressure. Consequently, a 24-h session of prone positioning with vvECMO was performed which was associated with an improvement in respiratory function (Table 1). The detailed procedure and the corresponding pictures are presented in the Electronic

Table 1 Respiratory parameters before, per and after 24-h session of prone positioning under vvECMO

Respiratory parameters	Before prone position	Per prone position (1 h after)	Supine position (12 h after)
Fraction of inspired oxygen (FiO_2) on ventilator (%)	80	80	45
Partial pressure oxygen in arterial blood (PaO_2) (mmHg)	67	131	103
FiO_2 on extracorporeal membrane oxygenation (ECMO) (%)	60	60	45
ECMO output (l/min)	5.5	5.5	4.7
Positive end expiratory pressure (PEEP) (cmH_2O)	10	10	10
Plateau pressure (PP) (cmH_2O)	28	20	20
Static compliance (SC) (ml/cmH_2O)	23	32	36

Supplementary Material (ESM). During and after the prone positioning session, a major increase in sputum drainage was observed, which may explain the improvement in oxygenation. The post-prone position chest X-ray showed a clear re-aeration of the basal pulmonary parenchyma (Fig. 1, ESM). Forty-eight hours later and 7 days after the start of vvECMO, the patient was successfully decannulated. She was extubated 7 days later and discharged from the ICU after 27 days. Prone positioning and vvECMO are now considered to be two efficient rescue options in the treatment of refractory ARDS [1, 2]. The safety of vvECMO with the patient in the prone position was assessed in a retrospective study, with the authors reporting no increase in complication rate [3]. However, the efficacy of the combination of these therapies has never been considered. Apneic ventilation during cardiac surgery is known to generate posterobasal atelectasis, ventilation perfusion mismatch and intrapulmonary shunt secondary to diaphragmatic weakness and decreased sputum drainage [4]. There are very few descriptions of the use of prone positioning in addition to vvECMO in the literature [5]. As others, we assumed that the persistent refractory hypoxemia was not related to the initial process but rather a consequence of low Vt/low-frequency ventilation associated with the supine position. In the present case, the combination of vvECMO and prone positioning was associated with a dramatic improvement in oxygenation, in pulmonary and thoracic compliance and in chest X-ray findings (Fig. 1). Prone positioning may be a valuable therapy to treat vvECMO-related pulmonary side effects. Finally, prone positioning can be performed safely, as previously reported. It may therefore be efficient to hasten the weaning of vvECMO when atelectasis and ventilation/perfusion mismatch occur under ultra-protective ventilation even in patients in whom pre-ECMO prone positioning failed. Further studies are needed to conclusively assert the place and timing of prone positioning during ECMO therapy.

Conflicts of interest None.

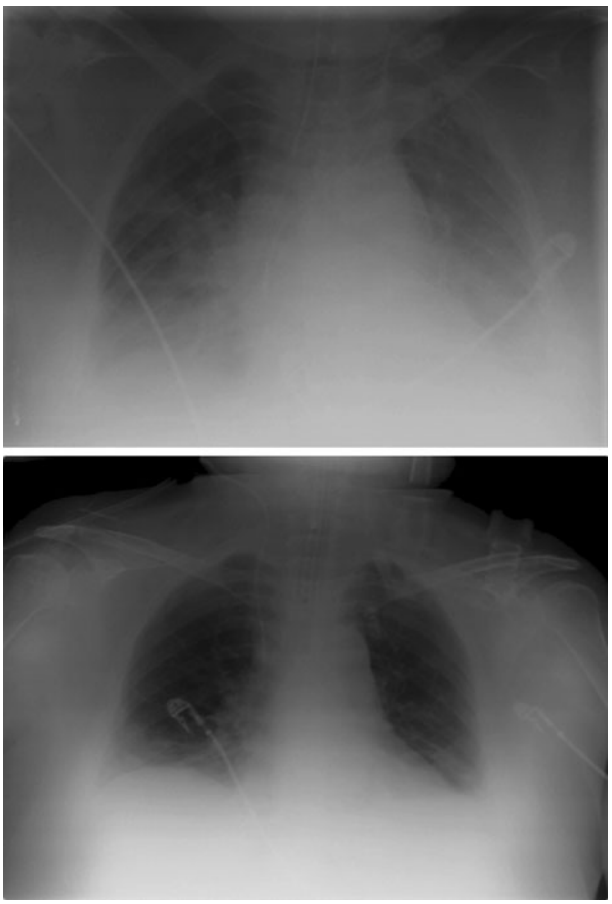

Fig. 1 Chest X-ray before (*top*) and 24-h after (*bottom*) patient was placed in prone position. Note that the central venous catheter was changed just after the end of the prone positioning session because the insertion point was inflamed

References

1. Guerin C, Reignier J, Richard JC, Beuret P, Gacouin A, Boulain T, Mercier E, Badet M, Mercat A, Baudin O et al (2013) Prone positioning in severe acute respiratory distress syndrome. N Engl J Med 368(23):2159–2168
2. Peek GJ, Mugford M, Tiruvoipati R, Wilson A, Allen E, Thalanany MM, Hibbert CL, Truesdale A, Clemens F, Cooper N et al (2009) Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial. Lancet 374:1351–1363
3. Haefner SM, Bratton SL, Annich GM, Bartlett RH, Custer JR (2003) Complications of intermittent prone positioning in pediatric patients receiving extracorporeal membrane oxygenation for respiratory failure. Chest 123:1589–1594
4. Hachenberg T, Tenling A, Nystrom SO, Tyden H, Hedenstierna G (1994) Ventilation-perfusion inequality in patients undergoing cardiac surgery. Anesthesiology 80:509–519
5. Otterspoor LC, Smit FH, van Laar TJ, Kesecioglu J, van Dijk D (2012) Prolonged use of extracorporeal membrane oxygenation combined with prone positioning in patients with acute respiratory distress syndrome and invasive Aspergillosis. Perfusion 27:335–337

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