

Recurrent pneumothorax after cesarean delivery in the critically ill pregnant with severe COVID-19 ARDS: a case report

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Abstract. – **OBJECTIVE:** Few data are available on the ICU management and on the possible respiratory complications of invasively ventilated pregnant patients affected by COVID-19 pneumonia, especially in the early phase of pregnancy. Tension pneumothorax has been previously described as a rare cause of respiratory failure after delivery, but its occurrence in the postpartum of COVID-19 patient has not been reported yet. We hereby describe the ICU management of a 23rd gestational week pregnant woman who underwent invasive mechanical ventilation, prone positioning, and cesarean delivery during her ICU stay for COVID-19 related pneumonia. Moreover, we focused on the occurrence and management of recurrent tension pneumothorax after the cesarean delivery.

CASE REPORT: A 23rd gestational week pregnant woman was admitted to the ICU for a COVID-19 bilateral pneumonia and underwent invasive mechanical ventilation and prone positioning. Cesarean delivery was planned during the ICU stay, while the patient was receiving invasive mechanical ventilation. After delivery, the patient experienced a recurrent pneumothorax that required the positioning of multiple chest drains.

CONCLUSIONS: In pregnant critically ill COVID-19 patients, mechanical ventilation management is particularly challenging, especially in the postpartum period. Prone positioning is feasible and can improve oxygenation and respiratory system compliance, while tension pneumothorax must be suspected if the respiratory function suddenly deteriorates after delivery.

Key Words:

Pregnancy, ICU, Mechanical ventilation, COVID-19.

Introduction

Pregnancy exposes women to a greater susceptibility to severe respiratory tract infections, but few data are available on the management of pregnant critically ill COVID-19 patient^{1,2}, especially in the early phase of pregnancy. A recent multinational cohort study enrolling women from 18 countries found that women with COVID-19 infection were at higher risk for maternal complication and had a higher mortality rate. Moreover, women affected by COVID-19 were found to be five times more at risk of intensive care unit admission as compared to the non-COVID-19 ones³.

Despite the COVID-19 vaccination during pregnancy has been strongly encouraged, vaccination rates among pregnant women stays low as compared to the general population⁴ and this can expose this specific population to a higher risk of hospital and ICU admission.

The management of critically ill COVID-19 patients is currently based on life support therapy. Prone positioning in both spontaneously breathing and mechanically ventilated patients, steroid and anticoagulants administration are the main treatments that showed efficacy, but all of them can be particularly challenging during pregnancy.

As concerns mechanical ventilation and prone positioning, specific measures must be taken to avoid compression of the pregnant abdomen and placental circulation impairment, which requires constant monitoring. Moreover, the physiological changes of the cardiopulmonary system, could furtherly represent a challenge for the use of lower

tidal volumes and lower pressures, and therefore, for pursuing protective mechanical ventilation.

Tension pneumothorax has been described as a rare complication after both vaginal⁵ and cesarean delivery⁶, but until now it has never been described as a complication of COVID-19 pregnant patients undergoing cesarean delivery.

We hereby present the case of a severe COVID-19 pneumonia in a 23rd gestational week (GW) pregnant woman requiring invasive mechanical ventilation, prone positioning, and the positioning of multiple chest drains for recurrent pneumothorax after preterm Caesarian delivery (CD).

Case Report

In March 2020, during the COVID-19 pandemic, a 34 years-old woman at the 22nd week and 6 days of gestation with a history of 2 caesarian sections was admitted to the emergency department with weakness and fever (temperature = 38.3°C). She was tachycardic (HR 100 bpm) and breathless (SpO₂ = 94% with nasal cannula, FiO₂ = 35%). The nasopharyngeal swab resulted positive for SARS-CoV-2 and a chest-X rays showed bilateral pneumonia (Figure 1A). She was admitted to the medical ward and started to be treated with steroids (Dexamethasone, 6 mg/die iv), Low Molecular Weight Heparin (LMWH 4000 UI/die) and antibiotics (ceftriaxone 2 g/die iv and azithromycin 500 mg/die iv). After three days, due to deterioration of gas exchange (PaO₂/FiO₂ = 197) and worsening of her general health conditions she was transferred to Intensive Care Unit (ICU).

Initially, non-invasive ventilation (NIV-PSV) was started, setting positive end expiratory pressure (PEEP) at 10 cmH₂O and pressure support of 10

cmH₂O, but the respiratory rate remained above 30/minute and the P/F ratio continued worsening. The interface was changed from the full-face to the helmet⁷, and PEEP was increased up to 16 cmH₂O with a pressure support of 16 cmH₂O and FiO₂ 100%. Despite this, the patient continued showing signs of respiratory distress, being the PEEP increase ineffective in improving gas exchange (P/F 97). Therefore, after a multidisciplinary team discussion (intensive care physicians, infectious disease specialist, obstetricians and neonatologist), the patient was intubated, and invasive mechanical ventilation was started on the 6th day from ICU admission (gestation week, GW 24+1 day). The ventilator was set on volume-controlled mode, with a tidal volume of 420 ml (7 ml/kg), respiratory rate (RR) 25 bpm, FiO₂ 95% and PEEP 10 cmH₂O. The driving pressure (DP) was 11 cmH₂O, with end-tidal to arterial CO₂ ratio (EtCO₂/PaCO₂) of 0.77⁸ and a P/F ratio of 125.

In the following days, the ventilatory treatment was set to guarantee lung protection, by using low tidal volumes (TV ≤ 8 ml/kg of ideal body weight) and keeping the plateau pressure (Pplat) < 30 cmH₂O. The obstetric fetal growth monitoring showed regular flow into the uterine arteries, normal growth, and regular fetal movements, despite ongoing sedation and muscle relaxant infusion.

For a further deterioration of gas exchange (P/F 72) on day 7 from ICU admission, a 24-hour cycle of prone positioning was started⁹. The prone positioning maneuver determined an improvement in oxygenation (P/F 147) and in respiratory system compliance. After 24 hours of prone positioning, the patient was placed back in supine position but due to a new reduction of arterial oxygenation (P/F 88) a second 24-hour cycle of prone positioning was immediately started (GW 24+4). After 24 hours, at the

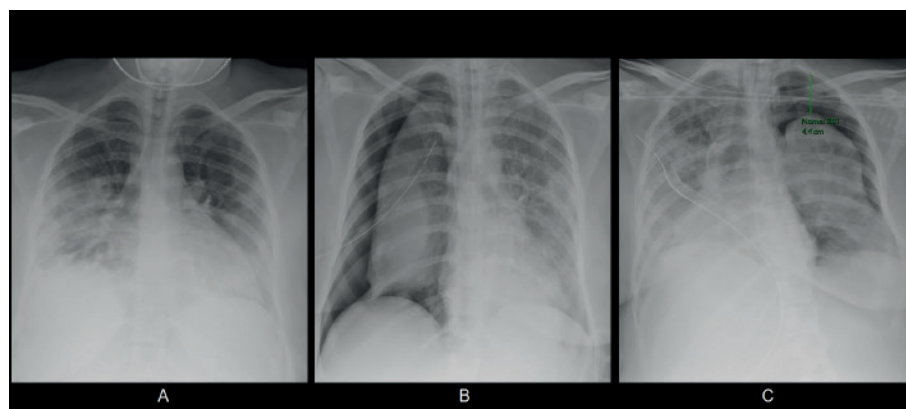


Figure 1. Chest X ray at the emergency department admission (A), after the right pneumothorax (B) and the left pneumothorax (C).

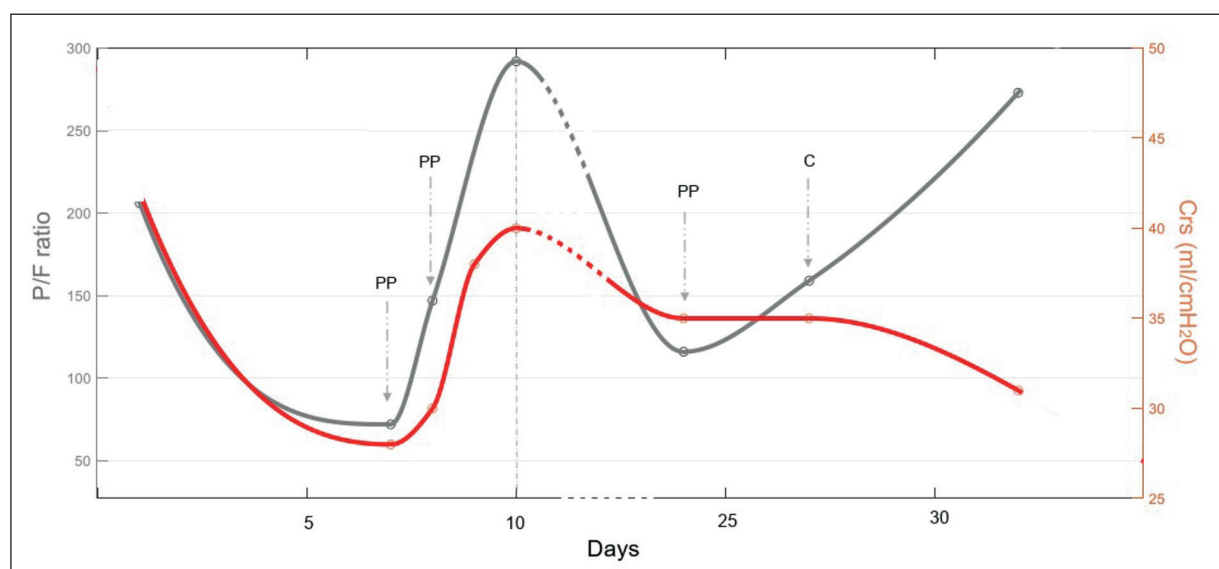


Figure 2. P/F and respiratory system Compliance trends during the ICU stay. PaO₂ /FiO₂ ratio (P/F ratio, grey line, left y axis) and Compliance of the respiratory system (CrS, red line, right y axis) trends during first month of ICU stay. PP= prone positioning; C= Cesarean delivery.

resupination the P/F ratio remained stable between 170 and 300 mmHg.

After the second prone positioning cycle, while gas exchange ameliorated, the hemodynamics gradually became instable requiring high doses of norepinephrine (up to 0.8 µg/kg/min). Therefore, since the patient's clinical conditions remained critical, the multidisciplinary team set the GW 27+1 as the date for caesarian delivery (CD). Furthermore, to face surgery with acceptable pulmonary function, a third 48 hours of prone positioning was performed on GW 26+5.

The CD was done without major complications and the newborn (body weight 1.100 g) was delivered and immediately transferred to the neonatal intensive care unit for assistance. A few hours after CD, a chest X-ray was performed for the occurrence of respiratory distress and worsening of respiratory functions. The x-ray showed the presence of a massive right pneumothorax (Figure 1B) and a chest drain was positioned with slow improvement of the patient's conditions. After three days, a new sudden worsening of gas exchange suggested the development of a second pneumothorax, which was confirmed on the left lung (Figure 1, C) and required the positioning new chest drain.

The patients' condition improved (P/F > 200) and weaning from mechanical ventilation was therefore continued using Neurally Adjusted Ventilatory Assist (NAVA)¹⁰ until tracheostomy was removed 55 days from admission. After 65 days of ICU stay, she was

finally discharged to rehabilitation ward. She went back home after 3 months, and 14 days of hospital stay with the need of night-time O₂-supplement.

Discussion

In this case report we reported the ICU management of a young pregnant woman affected by a severe form of acute respiratory failure caused by COVID-19 infection. We hereby described the safe management of prone positioning, the experience of delivery and the occurrence of recurrent pneumothorax during weaning from mechanical ventilation just after the cesarean delivery.

Pregnant patients are rarely admitted to the ICU^{11,12} but pregnancy exposes women to a greater susceptibility to severe respiratory tract infections and the pro-inflammatory state during the first and third trimester could make them more susceptible to the development of a cytokine storm after infections^{13,14}. The decrease of functional residual capacity occurs throughout all pregnancy, being higher in the third trimester (up to 25%)¹⁵. These changes cause a reduction of respiratory system compliance while generally lung compliance is not altered¹⁶. This implies that the pressure limits commonly suggested (i.e., Pplat of 30 cmH₂O) may not be appropriate in the pregnant and a slightly different target might be needed.

Prone positioning was effective and safe in our patient. It is known that sustained oxygenation

improvement after first prone positioning is related to improved outcome in COVID-19 ARDS¹⁷. Prone positioning has been proven to reduce mortality in ARDS¹⁸, but only limited evidence exists on prone position in pregnant women and few data are available on the possibility of direct fetal injury, aortocaval compression or fetal monitoring difficulties. However, with appropriate support positioning, it has been safely accomplished and described as potentially advantageous in pregnant patients with COVID-19⁹. We performed three prone positioning cycles, with no problem during the maneuvers and improvement in oxygenation and respiratory system compliance (Figure 2).

Since pregnancy leads to increased oxygen consumption and PaCO₂ can modify uterine blood flow, an accurate gas exchange monitoring is relevant. An SpO₂ ≥ 95% has been suggested in pregnant to ensure an appropriate oxygenation of the fetus¹⁹, but the hemoglobin binding curve in COVID-19 patients seems altered²⁰, making therefore SpO₂ a weak target for oxygen delivery.

Interestingly, our patient was affected by recurring pneumothorax after delivery and during the phase of weaning from mechanical ventilation. The incidence of this complication is higher in patients with ARDS who are on mechanical ventilation for > 2 weeks²¹. COVID-19 severe pneumonia can lead to ARDS which can evolve in pulmonary fibrosis and similar changes, due to diffuse alveolar damage, may contribute to the mechanism of pneumothorax, complicating clinical evolution. In COVID-19 ARDS pneumothorax rate is about 15%, significantly higher than the 2.9% in mechanically ventilated patients in the ICU^{22,23}.

Pneumothorax after delivery has been described before and can be considered a rare complication in patients undergoing cesarean delivery under general anesthesia. From a physiological point of view, it might be possible that the increased chest-wall compliance determined by the abdominal decompression may have led to an increase in end expiratory lung volume for the same value of positive end expiratory pressure, during and just after the cesarean delivery. This mechanism can be furtherly exaggerated when the lungs are not previously healthy and affected by a bilateral interstitial pneumonia.

Conclusions

Acute respiratory distress syndrome related to COVID-19 infection during pregnancy can be

life threatening. Prone positioning was effective and safe in increasing arterial oxygenation. Tension pneumothorax must be suspected if the respiratory function suddenly deteriorates after delivery in mechanically ventilated critically ill COVID-19 patients. Mechanical ventilation must be continuously titrated, especially in the post-partum period, to account for the increase in compliance of the respiratory system and the increased risk of pneumothorax.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Informed Consent

Informed consent was obtained from all individual participants included in the study.

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