Case Reports in Women's Health 31 (2021) e00339

Contents lists available at ScienceDirect

Case Reports in Women's Health

journal homepage: www.elsevier.com/locate/crwh

Conscious prone positioning in a pregnant patient with COVID-19 respiratory distress: A case report and review

Erica Testani [a,*], Sara Twiehaus [a], Thaddeus Waters [b], Xavier Pombar [c]

[a] Department of Obstetrics and Gynecology, Rush University Medical Center, 1620 West Harrison Street, Chicago, IL 60612, United States of America
[b] Chair of Maternal Fetal Medicine, Rush University Medical Center, 1620 West Harrison Street, Chicago, IL 60612, United States of America
[c] Department of Maternal Fetal Medicine, Rush University Medical Center, 1620 West Harrison Street, Chicago, IL 60612, United States of America

ARTICLE INFO

Keywords:
COVID-19
Prone positioning
Pregnancy

ABSTRACT

Prone positioning has been used for decades to improve oxygenation in patients with acute respiratory distress syndrome. With the COVID-19 pandemic there has been a growing emphasis on the utilization of prone positioning for non-intubated patients as a means of preventing invasive ventilation and improving outcomes. In this case report, a patient is presented with acute hypoxemic respiratory failure in late pregnancy who experienced significant improvements in oxygenation with prone positioning. Additionally, the physiology of prone positioning is reviewed, as well as its mechanism and safety in pregnancy.

1. Introduction

Prone positioning has been utilized since the 1970s to treat severe hypoxia in patients with acute respiratory distress syndrome (ARDS) [1]. In 2011, Guérin et al. reported a significant decrease in 28-day and 90-day mortality with early application of prolonged prone positioning sessions in patients with severe ARDS [2]. More recently, 40 observational studies have demonstrated mild to dramatic improvements in oxygenation in patients placed in the prone position [3]. With the advent of the COVID-19 pandemic, a new focus has been placed on prone positioning as a method of improving oxygenation in a wide range of patients, from those intubated in the intensive care unit to conscious patients in the emergency department. In the case reported here, prone positioning was used in a non-intubated pregnant woman with hypoxic respiratory distress secondary to COVID-19 infection. The mechanism of prone positioning and its efficacy and safety in pregnancy are also reviewed.

2. Case presentation

A 25-year-old gravid woman (G1P0) at 28 6/7 weeks of gestation was transferred from a local hospital to the intensive care unit of a tertiary-care referral center for worsening hypoxic respiratory failure secondary to known COVID-19 pulmonary infection. The patient had a previous history of Graves' disease.

On admission the patient reported worsening nonproductive cough, exertional dyspnea, nausea and emesis for one week. Admission vitals were as follows: heart rate 115 beats per min, blood pressure 111/77 mmHg, temperature 105.2 °F, respiratory rate 20/min and spO2 95% on 10 L high-flow nasal canula. Chest radiography demonstrated bilateral patchy opacities worse in the right lower lobe. The admission ultrasound demonstrated a single, live fetus with an estimated fetal weight of 1271 g. A computed tomography scan was negative for pulmonary embolism. A transthoracic echocardiogram was within normal limits. Her laboratory results were significant for an elevated CRP, LDH, and d-dimer (Table 1). An arterial blood gas test was significant for hypoxemia (pH 7.47, $PaCO_2$ 24 mmHg, PaO_2 67 mmHg, HCO_3 17.7 mmol/L). Monitoring of the fetal heart rate demonstrated intermittent spontaneous decelerations. The obstetrical team decided to administer a 2-day course of betamethasone because of concerns for a premature delivery. Due to the severity of the findings, the patient received therapeutic heparin for anticoagulation and a 5-day course of remdesivir.

On hospital day 2, the patient made minimal improvements in oxygenation, with persistent exertional dyspnea, a respiratory rate of 30–38/min and an spO2 of 95%. She was weaned to 8 L/min high-flow nasal canula. On hospital day 3 the decision was made to place the patient in the prone position due to continued O2 requirement of 8 L/min high-flow nasal canula despite attempts to wean to a lower

* Corresponding author.
E-mail addresses: Erica_Testani@rush.edu (E. Testani), Sara_J_Twiehaus@rush.edu (S. Twiehaus), Thaddeus_Waters@rush.edu (T. Waters), Xavier_Pombar@rush.edu (X. Pombar).

https://doi.org/10.1016/j.crwh.2021.e00339
Received 10 June 2021; Received in revised form 24 June 2021; Accepted 25 June 2021
Available online 29 June 2021

supplemental oxygen rate. Once in the prone position, the patient experienced an immediate rise of spO2 from 95% to 100%. The patient remained in the prone position for approximately 4 h, during which time she was weaned from 8 L/min to 3 L/min nasal canula with an spO2 of 98–100%.

On hospital day 4 the patient was again placed in the prone position due to continued dyspnea and intermittent desaturation to low 90s with exertion. She remained in the prone position for approximately 6 h, during which time she maintained an spO2 > 95% on 3 L/min of oxygen by nasal canula. By mid-day, the patient was deemed stable and transferred from the ICU to labor and delivery. There she remained in the prone position for an additional 6 h and eventually weaned to 2 L/min of oxygen by nasal canula. By hospital day 6 the patient was transitioned to room air and she was ultimately discharged on hospital day 7.

The patient's prenatal course following discharge from hospital was unremarkable. Ultimately, she underwent a spontaneous, term vaginal delivery of a healthy male infant with APGAR scores of 9/9. The infant was COVID-19 negative at the time of delivery.

Informed consent was obtained for the publication of this case report.

3. Discussion

This case demonstrates rapid improvement of oxygenation in a gravid woman with COVID-19 pneumonia after being placed in the prone position. Recently the Society for Maternal-Fetal Medicine has included prone positioning as a method for managing intubated and non-intubated pregnant patients with COVID-19 [4]. However, few studies have documented the safety and efficacy of placing pregnant patients in the prone position. Samanta et al. documented the case of a gravid woman at 31 weeks of gestation with hypoxic respiratory failure secondary to H1N1 infection who was intubated. The patient demonstrated significant improvement in oxygenation when she was placed in the prone position [5].

There have been recent reports assessing the feasibility and effectiveness of prone positioning in awake, non-intubated patients with COVID-19 [6–8]. The institution where this patient was cared for has developed guidelines on the implementation of prone positioning in the treatment of symptomatic, non-intubated pregnant patients (Table 2). The use of pregnancy-specific mattress or combination of pillows and sheets can be used to accommodate the gravid uterus.

Prior to prone positioning, assessment must be performed to determine if patients are appropriate candidates. Indications for this population include a requirement for more than 2 L/min O2 to maintain SaO2 ≥ 95% or a respiratory rate over 30 breaths per minute. Absolute contraindications are few but include spinal instability, facial or pelvic fractures, and an open abdominal wound. Relative contraindications include confusion or inability to independently change position. The patient should be positioned such that she is lying on the upper chest and pelvis, supported by their arms. Pillows and foam should be placed at pressure points to maximize patient comfort and avoid significant pressure on the gravid uterus. Continuous maternal and fetal monitoring, including EKG, continuous spO2 and fetal heart rate are required to identify any deterioration in clinical status. The goal is to maintain the patient in the prone position for as long as can be tolerated. Prone positioning should be discontinued if there is no improvement within 10–15 min of onset, worsening hemodynamic decompensation, if fetal heart rate is unable to be continuously monitored or if significant improvement is maintained when the patient is placed back in the supine position.

Prone positioning improves oxygenation by three principal mechanisms. The first is increased uniformity of ventilation. The prone position allows for more even distribution of ventilation and perfusion when compared to the supine position, leading to improved oxygenation throughout the entire lung. This theory has been corroborated by CT,

Table 2
Guideline for prone positioning.

Timing
1. Consider placing patient in a prone position if they require more than 2 L/min of O2 by nasal cannula to maintain SaO2 ≥ 95 and/or respiratory rate is >30 per minute for significant portion of time.
Determine Following Prior to Repositioning
1. Ability to move independently in bed.
2. Mental status
3. Contraindications to placing in prone position.
Monitoring and Positioning of the Patient
1. EKG leads are placed if clinically indicated.
2. SpO2 probe (continuous) should be placed on patient if not already in use.
3. Place FHR straps in non-pressure point areas once the patient is in the prone position.
4. Verify that oxygen supply tubing is unobstructed.
5. Pillows may be placed under the hips, or under the legs, as needed, for comfort.
6. Place call bell and phone within reach
7. Consider rotating position every 4 h. However, the patient may remain in the prone position for as long as they can tolerate it if the patient desires.
8. Increase O2 supply to patient whenever repositioning of the patient is performed.
Documentation
1. SpO2
2. Oxygen device and oxygen rate (L/min of O2)
3. Respiratory rate
4. Presence of dyspnea should be assessed before and after placing patient in the prone position.
Discontinuation of Prone Position
1. No improvement within 10–15 min of being placed in the prone position.
2. Worsening of hemodynamic decompensation once in the prone position
3. If FHR is unable to me monitored, continue discontinuation on case-by-case basis.
4. Significant improvement is maintained when placed back in the supine position.
Consider Transfer to ICU
1. Inability to maintain oxygen saturation ≥ 95% (PaSO2) with supplemental oxygen or rapidly escalating supplemental oxygen need.
2. Hypotension (MAP <65) despite appropriate fluid resuscitation (~1000 mL bolus of crystalloid fluids).
3. Evidence of new end-organ dysfunction (eg, altered mental status, renal insufficiency, hepatic insufficiency, cardiac dysfunction, etc.)

Table 1
Maternal clinical laboratory values during hospital admission.

	Reference Range	HD1	HD2	HD3	HD4	HD5	HD6	HD7
D-dimer (mg/L)	0–0.6	**0.84**	NA	NA	0.45	**0.72**	**1.94**	**1.51**
CRP (mg/L)	0–8.0	**114.6**	**160.4**	**93.6**	**37.7**	**14.8**	**13.8**	**11.5**
LDH (U/L)	110–240	**291**	**349**	**287**	**291**	**384**	**309**	**267**
Ferritin (ng/mL)	12–260	94	119	151	132	NA	NA	NA
CPK (U/L)	10–205	113	95	52	40	44	37	33
Troponin (ng/mL)	0–0.4	0.003	NA	NA	NA	NA	NA	NA
WBC (x 10^9/L)	3.4–10.0	**12.5**	**12.8**	9.2	7.7	5.1	6.0	6.4
Hgb (g/dL)	12.0–15.5	**10.0**	11.1	11.9	**10.4**	**10.3**	**10.7**	**9.9**
Lymphocyte count (x 10^9/L)	0.7–5.2	0.97	0.81	1.05	0.87	1.36	1.53	1.99
PLT (x 10^9/L)	140–450	244	268	272	355	375	374	321
ALT (U/L)	10–40	25	26	20	19	34	**66**	**77**
AST (U/L)	10–40	37	39	29	31	**57**	**81**	**82**

Abbreviations: NA, not assessed.

nuclear, and inert gas experiments which measured aeration and ventilation in the prone position and demonstrated improved homogeneity [6,9,10].

The second mechanism relates to the alteration of lung mass. Lung shape is conical with more mass and alveoli located in the dorsal lung. In the supine position the dorsal lung is compressed by the weight of the abdominal cavity and mediastinum. In ARDS the increased edema and lung mass result in compression atelectasis of the dependent lung fields, i.e., the dorsal lung when supine. The prone position relieves the compression, resulting in recruitment of more alveoli in the dorsal lung for increased gas exchange [6,10,11].

The final mechanism relates to modifications of chest wall compliance. In normal thoracic anatomy, the dorsal chest wall is less compliant than the ventral chest. In the supine position, the chest wall compliance is determined by the relative elasticity of the ventral chest wall and the diaphragm since the dorsal thoracic cage is in contact with the bed and therefore restricted. In the prone position, overall chest compliance is decreased because it is dependent on the dorsal chest for many of its movements. Paradoxically this leads to improved distribution of gases toward the ventral and para-diaphragmatic lung, resulting in higher recruitment of these areas [7,11,12].

Patients with ARDS respond differently to the prone position in terms of degree and timing of improvement. Oxygen response is typically measured by improvements in PaO_2/FIO_2. Observational studies have shown that the prevalence of improved oxygenation response varies from 54% to 100%, with 20% of studies reporting an improvement in less than 70% of patients [3]. Prone positioning is most effective in improving oxygenation when initiated early (i.e., less than 4 days from onset of ARDS) during the exudative phase, when congestive and compressive atelectasis are predominant features. Additionally, the time required for oxygenation to improve during prone positioning is highly variable. Typically, patients experience a rapid initial improvement (<30 min), followed by a period of slower improvement over a variable amount of time. Several studies have demonstrated a plateau in improvement at 2–4 h, while others observed that subjects required up to 24–48 h before oxygenation improved. Despite initial improvements, many studies have noted that this is often transient and diminishes over a variable amount of time when the patient is returned to the supine position [3].

Placing patients in the prone position for a long period is highly recommended in cases of severe ARDS, as characterized by a PaO_2/FIO_2 of 100 mmHg according to the Berlin criteria [6,10,11]. This recommendation is based on 5 major studies, including the 2013 PROSEVA trial, which demonstrated an absolute mortality risk reduction of 17% and a relative risk reduction of 50% in patients placed in the prone position for 17 h for approximately 4 days [2]. In moderate ARDS the pattern of response is less clear. However, previous meta-analyses suggest that prone positioning should be strongly considered in patients with moderate ARDS with an PaO_2/FIO_2 lower than 150 mmHg. Alternatively, long-term prone positioning has historically been discouraged in patients with mild ARDS (PaO_2/FIO_2 between 200 and 300 mmHg) as research fails to demonstrate any survival benefit [6,10,11].

Research on placing patients in the prone position has focused on intubated patients in the setting of an intensive care unit. However, amidst the COVID-19 pandemic new studies have examined the benefits of the prone position in non-intubated patients. Elharrar et al. examined 24 patients with acute hypoxemic respiratory failure. Of the 15 patients who tolerated the prone position, six demonstrated a mean increase in PaO2 of more than 20% from baseline. Three of the patients returned to baseline PaO2 after supination [7]. Sartini et al. performed a 1-day cross-sectional study that included 15 awake patients with mild or moderate ARDS. Patients received noninvasive ventilation with sessions of prone positioning. The patients had a median of 2 sessions of prone positioning for approximately 3 h. Oxygenation and respiratory rate improved while the patient was in the prone position. These improvements persisted for 1 h after each session in most patients [8].

This case report has demonstrated the success and safety of implementing prone positioning in non-intubated pregnant women. There have been case reports of using the prone position in pregnancy as well as position papers supporting its use in the management of pregnant patients infected with COVID-19 [4,13–16]. However, evidence that placing patients with COVID-19 infections in the prone position reduces overall morbidity is lacking. Studies evaluating the potential impact of placing these patients in the prone position on maternal and fetal outcomes are needed.

Contributors

Erica Testani was involved in patient care and drafting the manuscript.

Sara Twiehaus was involved in patient care and drafting the manuscript.

Thaddeus Waters was involved in patient care and drafting the manuscript.

Xavier Pombar assisted in topic research and writing the manuscript.

Conflict of interest

The authors declare that they have no conflict of interest regarding the publication of this case report.

Funding

No funding from an external source supported the publication of this case report.

Patient consent

Obtained.

Provenance and peer review

This case report was peer reviewed.

References

[1] A.C. Bryan, Conference on the scientific basis of respiratory therapy. Pulmonary physiotherapy in the pediatric age group. Comments of a devil's advocate, Am. Rev. Respir. Dis. 110 (6 Pt 2) (1974) 143–144.

[2] C. Guérin, J. Reignier, J.C. Richard, et al., Prone positioning in severe acute respiratory distress syndrome, N. Engl. J. Med. 368 (23) (2013) 2159–2168.

[3] R.H. Kallet, A comprehensive review of prone position in ARDS, Respir. Care 60 (11) (2015) 1660–1687.

[4] Society for Maternal Fetal Medicine, Management Considerations for Pregnant Patients With COVID-19, January 7th, 2021.

[5] S. Samanta, S. Samanta, J. Wig, A.K. Baronia, How safe is the prone position in acute respiratory distress syndrome at late pregnancy? Am. J. Emerg. Med. 32 (6) (2014), 687.e1–687.e6873.

[6] A. Coppo, G. Bellani, D. Winterton, et al., Feasibility and physiological effects of prone positioning in non-intubated patients with acute respiratory failure due to COVID-19 (PRON-COVID): a prospective cohort study, Lancet Respir. Med. 8 (2020) 744–765. S2213–2600(20)30268-X.

[7] X. Elharrar, Y. Trigui, A.M. Dols, et al., Use of prone positioning in nonintubated patients with COVID-19 and hypoxemic acute respiratory failure, JAMA. 323 (22) (2020) 2336–2338.

[8] C. Sartini, M. Tresoldi, P. Scarpellini, et al., Respiratory parameters in patients with COVID-19 after using noninvasive ventilation in the prone position outside the intensive care unit, JAMA. 323 (22) (2020) 2338–2340.

[9] E.L. Scholten, J.R. Beitler, G.K. Prisk, A. Malhotra, Treatment of ARDS with prone positioning, Chest. 151 (1) (2017) 215–224.

[10] L. Gattinoni, P. Taccone, E. Carlesso, J.J. Marini, Prone position in acute respiratory distress syndrome. Rationale, indications, and limits, Am. J. Respir. Crit. Care Med. 188 (11) (2013) 1286–1293.

[11] L. Gattinoni, M. Busana, L. Giosa, et al., Prone positioning in acute respiratory distress syndrome, Semin. Respir. Crit. Care Med. 40 (1) (2019) 94–100.

[12] L.M. Malbouisson, C.J. Busch, L. Puybasset, Q. Lu, P. Cluzel, J.J. Rouby, Role of the heart in the loss of aeration characterizing lower lobes in acute respiratory distress syndrome. CT Scan ARDS Study Group, Am. J. Respir. Crit. Care Med. 161 (6) (2000) 2005–2012.

[13] W.T. Schnettler, Y. Al Ahwel, A. Suhag, Severe acute respiratory distress syndrome in coronavirus disease 2019-infected pregnancy: obstetric and intensive care considerations, Am. J. Obstet. Gynecol. MFM 2 (3) (2020) 100120.
[14] R.A.M. Pierce-Williams, J. Burd, L. Felder, et al., Clinical course of severe and critical coronavirus disease 2019 in hospitalized pregnancies: a United States cohort study, Am. J. Obstet. Gynecol. MFM 2 (3) (2020) 100134.
[15] M.C. Tolcher, J.R. McKinney, C.S. Eppes, et al., Prone positioning for pregnant women with hypoxemia due to coronavirus disease 2019 (COVID-19), Obstet. Gynecol. 136 (2) (2020) 259–261.
[16] J.P. Vogel, B. Tendal, M. Giles, et al., Clinical care of pregnant and postpartum women with COVID19: living recommendations from the National COVID-19 Clinical Evidence Taskforce, Aust. N. Z. J. Obstet. Gynaecol. 60 (6) (2020) 840–851.