SUCCESSFUL TREATMENT OF SEVERE ARDS CAUSED BY COVID-19 PNEUMONIA IN A PARTURIENT WITH NON-INVASIVE VENTILATION- A CASE REPORT

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УСПЕШНО ЛЕЧЕНИЕ НА ТЕЖЪК ARDS, ПРИЧИНЕН ОТ COVID-19 ПНЕВМОНИЯ У ЖЕНА В ПЕРИПАРТАЛНИЯТ ПЕРИОД С НЕИНВАЗИВНА ВЕНТИЛАЦИЯ- КЛИНИЧЕН СЛУЧАЙ

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Abstract

Recent COVID-19 pandemic has led to worldwide increase in cases of Acute Respiratory Distress Syndrome. Pregnancy is associated with physiological respiratory, cardiovascular and immunological changes, which could lead to development of severe viral pulmonary complications. That cause higher rate of maternal and fetal morbidity and mortality.

Application of non –invasive ventilation strategies for treatment of mild to moderate cases of hypoxic Acute Respiratory Distress Syndrome in pregnant women may improve their condition and decrease cases of endotracheal intubation and invasive mechanical ventilation. More investigations for the most successful method of non-invasive mechanical ventilation in pregnant women are necessary.

Резюме

Възникналата през последните години пандемия от КОВИД-19 увеличи в световен мащаб случаите на остър респираторен дистрес синдром при възрастни. Бременността е свързана с физиологични промени, засягащи дихателната, сърдечно-съдовата система и имунитета, които могат да предизвикат тежки белодробни усложнения в хода на респираторни вирусни инфекции. Това от своя страна значително повишава майчината и феталната смъртност. Приложението на неинвазивна механична вентилация при лечението на лек до умерен хипоксичен остър респираторен дистрес синдром при бременни жени е доказано че намалява смъртността, случаите на ендотрахеална интубация и инвазивна вентилация. Като все още няма достатъчно изследвания върху това кой от методите на неинвазивна вентилация е най-успешен при бремени жени.

Keywords: COVID-19, ARDS, CPAP, BIPAP, HFNC
Ключови думи: COVID-19, ARDS, CPAP, BIPAP, HFNC

Introduction : During pregnancy there are some important respiratory changes- upward displacement of diaphragm, decreasing expiratory reserve volume and functional residual capacity (FRC), increased respiratory resistance, minute ventilation, oxygen consumption, mucosal edema of upper airways, chronic mild respiratory alkalosis.(1) Cardiovascular changes include rise in cardiac output, decreased systemic vascular resistance, also immunological response is suppressed, additional complement activation is seen, that increases incidence of thrombosis. Therefore the pregnancy is a risk factor for severe viral SARS-CoV-2 induced ARDS which is commonly associated with poor maternal and fetal outcomes. (2)

Non-invasive ventilation (NIV) refers to the delivery of mechanical ventilation to the lung, without endotracheal tube. There 2 basic modalities- Continuous Positive Airway Pressure (CPAP), Non-Invasive Pressure Support Ventilation (NIPSV). CPAP is a simple technique that is applied via portable devices and ventilators and different interfaces – facial, nasal mask, helmet and level of continuous positive airway pressure is between 5-10 cm H_2O, it could reduce preload and afterload. NIPSV always requires ventilator with this technique patient`s inspiratory efforts trigger the ventilator to deliver a decelerated flow in order to achieve and maintain a preset pressure (pressure support). This modality is also called bi level (BIPAP) because it is generally applied using 2 levels of pressure- pressure support on inspiration (IPAP)-15-20 cm H_2O and the positive expiratory pressure (EPAP)-5-10 cm H_2O. It could be considered as CPAP mode with assisted inspiration. NIPSV is proved to increase oxygenation and it is most effective in patients with hypoventilation and respiratory acidosis. In NIPSV mode clinicians may pay attention to patients- ventilator synchronicity. High Flow Nasal Cannula (HFNC) delivers to the patient high flow between 30-60 l/min which creates Positive End Expiratory Pressure (PEEP). According to same studies application of non-invasive mechanical ventilation strategies – Continuous Positive Airway Pressure (CPAP), Bi level Positive Airway Pressure (BIPAP),

High Flow Nasal Oxygen Cannula (HFNC) could improve oxygenation and reduce mortality, cases of endotracheal intubation and invasive mechanical ventilation, length of Intensive Care Unit (ICU) stay in patients with hypoxic ARDS compared to standard oxygen therapy (3,4,5,6).There is not enough dates about which method of non-invasive ventilation is the most effective in treatment of COVID-19 induced hypoxic ARDS. In same investigations HFNC decreased significantly mortality and improve oxygenation compared to CPAP mode, but it did not reduce the rate of endotracheal intubation and invasive mechanical ventilation and also duration of ICU `s stay. But there are missing dates in the inclusion criteria for severity of ARDS, on which day after the onset of symptoms NIV was started, also about type of interface used in CPAP mode of NIV, etc. Other studies showed that helmet interface of CPAP reduces mortality and improved oxygenation in cases of hypoxic moderate ARDS, but they did not find significant difference between frequency of cases of endotracheal intubation and invasive mechanical ventilation. (7, 8, 9). There are not enough studies about advantages of NIV in treatment of SARS-CoV-2 induced ARDS in pregnant population, but its use is recommended. (10,11,12). The most effective, safe and well-tolerated method of treatment of hypoxic ARDS is considered to be application of CPAP with helmet interface. Helmet CPAP improve oxygenation, increases ratio - partial arterial pressure of oxygen (PaO_2)/ inspiratory fraction of oxygen (FiO_2), decreases cases of endotracheal intubation and invasive mechanical ventilation and length of ICU`s stay. The value of applied CPAP was between 5-10 cm H_2O. Its optimal level was estimated according to improvement in clinical condition of patient and PaO_2 /FiO_2 ratio, while FiO2 stayed unchanged. (10). Application of non-invasive ventilation strategies in pregnant women with hypoxic ARDS caused by COVID-19 infection may avoid endotracheal intubation and preterm delivery. That could improve maternal and fetal outcome.

Case report : This case concerned woman in 36 weeks pregnant, who was admitted in emergency department of University Hospital Specialized in Obstetric and Gynecology „Maichin dom" , Sofia, Bulgaria. She was complaining of dyspnea, fever, shortness of breathing, fatigue, cough. These symptoms persisted one week. She was overweight without any accompanying diseases. She was with symptoms of respiratory failure- tachypnea, respiratory rate-35 /min, orthopnea, dyspnea, saturation 75 % , on auscultation physician heard moist rales and crepitations bilaterally in middle and low lungs` lobes, hemodynamic was stable. Standard oxygen therapy with face mask was started, her saturation increased to 85 %, but tachypnea, dyspnea, shortness of breath, orthopnea persisted. Her laboratory results in admission showed elevated liver enzymes, LDH, C- reactive protein (CRP), D dimer, ferritin and procalcitonin. Arterial Blood Gases analysis (ABG a) revealed hypoxia- PaO_2-73 mm Hg, PaO_2/FiO_2-146, hypocapnia partial arterial pressure of carbon dioxide ($PaCO_2$)-31 mm Hg, respiratory alkalosis- ph-7,48, ASAT-292, ALAT-138, LDH-1647, CPR-103, d-dimer-1,9, procalcitonin-3,0, ferritin-275, lymphopenia-0,9 g/l. In same studies high levels of CRP, procalcitonin, liver enzymes are associated with higher rates of mortality (13,14) .X-ray was performed and showed bilateral pulmonary infiltrates.

According to new global definition (14) she was diagnosed with hypoxemic severe ARDS due to viral SARS-CoV-2 infection and she was admitted in ICU. Treatment with non-invasive ventilation –CPAP - 8 cm H2O and FiO_2- 80 % was applied. After one hour her condition did not improve and fetal distress was diagnosed. Urgent cesarean section was performed and spinal anesthesia was applied. As local anesthetic hyperbaric bupivacaine was used in dose of 12,5 mg in combination with morphine- 0,1mg, they were injected into intrathecal space. The spinal anesthesia was performed on L2-L3 level and patient was in left lateral position, sensitive spinal block reached Th-6 dermatome. In operation room NIV with CPAP face mask was continued: CPAP-8 cm H_2O, FiO_2 -80 %, her saturation was 85-90 % and improved after delivery of the baby, who was with symptoms of fetal distress and was admitted to neonatal intensive care unit. She was infused with 2000 ml of crystalloids, ephedrine was used as vasopressor. The surgery proceeded without any complications and parturient was returned to ICU, where CPAP non-invasive ventilation continued. According to protocol of treatment of CARDS (Covid-19 associated ARDS) her therapy included corticosteroids- dexamethasone , anticoagulant, antibiotics- ceftriaxone, amikacin, conservative fluid treatment, non-invasive ventilation, etc.(16)

After preterm delivery of the baby patient`s oxygenation did not improved, her respiratory rate stayed above 30 /min, and PaO_2 /FiO_2 was 96 while CPAP was 10 cm H_2O, her work of breathing increased and that caused respiratory fatigue. At the first day after cesarean section she was switched to NIV/BIPAP mode- IPAP-18 cm H_2O, EPAP-5 cm H_2O, FiO_2- 75 %. In the next days her oxygenation slowly improved, her respiratory rate decreased to 25 -30 /min, she was with stable hemodynamic, there was tendency of reduction of values of CRP-89, liver enzymes- ASAT-118, ALAT-82, LDH-1554, but procalcitonin increased-3,3 that showed additional bacterial infection and samples were sent for microbiological studies. From ABG a- PaO_2 /FiO_2-111, respiratory alkalosis, ph-7,47, $PaCO_2$-32 mm Hg. The patient was consulted with cardiologist, who made echocardiography, which found that left heart ventricle was dilated without any significant valve`s diseases, systolic dysfunction and pericarditis were revealed. As conclusion the patient was diagnosed with myopericarditis due to viral infection, and cardiologist recommended electrolyte disorders to be treated with potassium and magnesium infusions. In her therapy antibiotics were changed with clindamycin and carbapenem and also ketoconazole was added. After 3 days on NIV/BIPAP mode treatment her oxygenation improved, respiratory rate normalized, she tolerated it with mild sedation. The parameters were IPAP-15 cm H_2O, EPAP-5 cm H_2O, FiO_2-70 % and results from ABG a- ph-7,44, PaO_2-111 mm Hg, $PaCO_2$-35 mm Hg PaO_2/FiO_2-222. X-ray was made and showed improvement. Her laboratory results also normalized. After 5

days on non-invasive ventilation treatment, the patient started to be cured with standard oxygen therapy via face mask- 10 l/min. She did not show any signs of respiratory fatigue, respiratory rate was 20- 25/min, her oxygenation was normal. After 10 days in ICU she was transferred to a postpartal ward and after 5 days she was discharged from the hospital.

Discussion : Covid-19 pandemic increased significantly cases of hypoxemic ARDS in pregnant population. According to recent researches annual maternal death caused by ARDS is about 9-14 % and perinatal mortality attributed to it was estimated between 20-30 % .(17) Because of associated physiological changes, pregnancy is proved to be a risk factor for development of severe COVID-19 illness, higher rates of admission in ICU, cases of endotracheal intubation and invasive mechanical ventilation, compared to non-pregnant population. Application of non-invasive ventilation strategies may improve patients` oxygenation and avoid endotracheal intubation, which is not recommended in pregnant patients, because of risk of pulmonary aspiration syndrome, mucosal edema of upper airways, decreased FRC, hypoxia, cardiac arrest, maternal and fetal death. NIV also reduced frequency of preterm deliveries and that improves neonatal outcome. In same studies treatment with each mode of NIV showed improvement in patient`s oxygenation, reduction in mortality`s rate and also in cases of endotracheal intubation and invasive mechanical ventilation. (3-9) According to studies, HFNC improved significantly oxygenation, increasing PaO_2/FiO_2 ratio compared to CPAP, but mortality rates and length of stay in ICU were almost the same in patients of 2 investigated groups. (4-7) But in these studies there were not important details about severity of ARDS, types of CPAP interface, etc. Another studies found that helmet CPAP was the most effective and well-tolerated. (8-10). There are not enough randomized controlled trials for treatment of pregnant women with SARS-CoV-2 induced ARDS with non-invasive ventilation. Protective mechanical ventilation strategies are considered as a golden standard in therapy of ARDS. (18) But there are not enough dates about its application in pregnant women. Permissive hypoxia and hypercapnia could lead to fetal distress, so in pregnant women PaO_2 have to be above 70 mm Hg, saturation above 93 %, $PaCO_2$ under 45 mm Hg. High level of PEEP in pregnant patients increases intrathoracic pressure and in combination with existed in late pregnancy compression of gravid uterus of vena cava inferior severe decrease in arterial blood pressure and cardiac output could occur. (19,20,21) According to randomized controlled multicenter study (22) maternal improvement in oxygenation occurred after preterm delivery in critically ill patients. Prone position is recommended in patients with moderate to severe ARDS, treated with non-invasive or invasive mechanical ventilation because it improved oxygenation and survival rates. (23,24). Dates about its application in pregnant population are insufficient, but it was supposed that prone position could be effective, feasible and tolerated in them.(25)

Conclusion : Application of non-invasive ventilation strategies could reduce maternal and fetal mortality due to hypoxic ARDS caused of COVID-19 infection. All types of NIV could be feasible, effective and well tolerated in pregnant women and could improve their condition, avoid endotracheal intubation, invasive ventilation and their complications. More investigation about treatment of ARDS in pregnant population are needed.

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