1. **Introduction**

Pulmonary edema usually presents as bilateral, symmetric perihilar opacities on chest radiographs. This "butterfly" appearance is more commonly seen with increased capillary pressure than with increased capillary permeability. An air bronchogram shows increased permeability for pulmonary edema.\(^2\)

\(^1\)Accurate evaluation of volume status is essential for appropriate therapy because inadequate assessment of volume status can result in unnecessary administration of therapy, which can increase mortality. There are several methods for evaluating fluid status. Following are several inspection methods for evaluating volume status: physical examination,
This study aimed to describe the use of inferior vena cava ultrasound in assessing fluid overload in severe preeclampsia patients.

2. Case presentation

A 23-year-old woman with G1P0A0 at 40 weeks of gestation came with complaints of shortness of breath 4 days before admission to the hospital, and it was getting worse. On physical examination, we found the patient was short of breath with a respiratory rate of 32 times per minute, smooth ronchi (+/+), SpO2 92% with non-breathing oxygen face mask 15 L per minute, heart rate 160 times per minute, lifting strength, CRT < 2 seconds, blood pressure 160/120 mmHg and GCS 15. Neurologic deficit and seizure were negative. Laboratory evaluation is presented in Table 1. The patient was diagnosed with acute pulmonary oedema in pregnancy with severe preeclampsia with ASA IVE. Then, the patient underwent emergency pregnancy termination by c-section under general rapid anesthesia with sequence induction (GARSI) followed by intensive treatment in the ICU.

Table 1. Laboratory evaluation of the patient before surgery.

<table>
<thead>
<tr>
<th>Items</th>
<th>Results</th>
<th>Items</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoglobin</td>
<td>8.1 g/dl</td>
<td>LDH</td>
<td>931 u/L</td>
</tr>
<tr>
<td>Hematocrit</td>
<td>23%</td>
<td>Ureum</td>
<td>17 mg/dl</td>
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<tr>
<td>Leucocyte</td>
<td>17,600/mm</td>
<td>Creatinine</td>
<td>0.8 mg/dl</td>
</tr>
<tr>
<td>Thrombocyte</td>
<td>290,000/µL</td>
<td>Prothrombin time</td>
<td>12.5 second</td>
</tr>
<tr>
<td>Erythrocyte</td>
<td>4x10⁶/µL</td>
<td>APTT</td>
<td>28.4 second</td>
</tr>
<tr>
<td>Blood glucose</td>
<td>86 g/dl</td>
<td>INR</td>
<td>0.96</td>
</tr>
<tr>
<td>SGOT</td>
<td>34 u/L</td>
<td>Natrium</td>
<td>130 mmol/L</td>
</tr>
<tr>
<td>SGPT</td>
<td>12 u/L</td>
<td>Potassium</td>
<td>3.8 mmol/L</td>
</tr>
<tr>
<td>Urine protein</td>
<td>+3</td>
<td>Chloride</td>
<td>107 mmol/L</td>
</tr>
</tbody>
</table>

In intensive care unit, patient was installed with endotracheal tube (ETT) 6.5 level 21 cm with synchronized intermittent mandatory ventilation (SIMV) mode VC f-14 Vt 320 PEEP 5.0 FiO2 50% with outcome Vt 300-330, fiot 22, MV 6 SpO2 98-99%, chest expansion right = left, vesicular breath sound (+/+), smooth ronchi (+/+), HR 100x/minute, blood pressure 121/61 mmHg, urine output > 1 ml/kg/hour with fluid balance (-) 760 ml/24 hours. Laboratory evaluation revealed hemoglobin level 7.8 g/dL, Ht 26%, leucocyte 39,200/mm, thrombocyte 219,000/µL, erythrocyte 3,55x10⁶/µL, blood glucose 83 g/dL, albumin 3.3, natrium 132 mmol/L, potassium 5.0 mmol /L, and calcium 0.97 mmol/L. Echocardiography examination showed fluid overload, left ventricle systolic failure and right ventricle. On chest X-ray examination showed pearly haziness and infiltrates in the lungs accompanied by air bronchograms in both lung fields, enlarged cast with cardio-thorax ratio (CTR) 68% and pulmonary oedema. The patient was treated with IVFD ringer-lactate 10 mL/hour, head up 30°, enteral diet per sonde 6x200 mL, morphine injection 10 mcg/kg/hour, midazolam 4 mg/hour, furosemide 10 mg/hour, packed red cell (PRC) transfusion 1 colf, plasmin 25% 100 mL, ranitidine intravenous 50 mg/12 hr, ampicillin sulbactam intravenous 1.5 gr/8 hour, metronidazole intravenous 500 mg/8 hours, paracetamol injection 1 gr/8 hours, MgSO4 1 gr/hour for 24 hours, methyldopa 500 mg/8 hours, nifedipine 10 mg/8 hours, vitamin C 50 mg/12 hours. Figure 1 show ultrasound examination on day 1 of ICU treatment.

The second day of treatment, the patient's condition was getting better with the airway still in ETT with mechanical ventilation SIMV mode f-14, Vt 320, PEEP 5.0, FiO2 50%, with outcome Vt 300-330, fiot 22, MV 6 SpO2 98 - 99%, chest expansion right = left, vesicular breath sound (+/+), smooth ronchi (-/-), HR 92 x/minute, blood pressure 111/64 mmHg, urine output > 1 ml/kg/hour with fluid balance (-) 2370 ml/24 hours, EEMVETT consciousness. On ultrasound examination, IVC also showed improvement with a diameter of about 2 cm and collapsibility > 50% (Figure 2). Chest X-ray revealed
cardiomegaly with pulmonary edema. Compared with the previous photo, the impression infiltrate is reduced (Figure 3). Morphine, midazolam, and MgSO₄ therapy were discontinued.

Figure 1. First-day IVC ultrasound. Maximum diameter 2.5 cm, minimum diameter 2.4 cm.

Figure 2. Second-day IVC ultrasound, diameter + 2 cm, collapsibility > 50%.

Figure 3. Comparison of chest radiographs day-1 (left) and day-2 (right).

On the third day of treatment in the ICU, the patient was extubated. The patient's condition was good, fully conscious with GCS E₄M₆V₅, spontaneous breathing, RR 18 x/minute, SpO₂ 99% with O₂ nasal cannula 2 L/minute, chest expansion right = left, vesicular breath sound (+ /+), smooth rhonchi (-/-), HR 86 x/minute, blood pressure 132/74 mmHg, urine output > 1 ml/kg/hour with fluid balance (-)1307 mL/24 hours. Laboratory evaluation on day 3 was Hb 8.4 g/dL, Ht 27 %, leucocyte 19.600/mm, thrombocyte 182.000/µL, erythrocyte 3.53x10⁶ million/µL, blood glucose 83 g/dL, natrium 138 mmol/L, potassium 3.1 mmol/L, chloride 97 mmol/L, calcium 0.97 mmol/L. On IVC ultrasound
examination, IVC diameter less than 1.5 cm and collapsibility more than 50%. The patient was given IVFD ringer lactate 10 cc/hour, head up 30°, soft diet 1500 kcal, ranitidine intravenous 50 mg/12 hours, ampicillin sulbactam intravenous 1.5 gr/8 hours, metronidazole 500 mg/8 hours, paracetamol injection 1 gr/8 hours, furosemide 20 mg/12 hours, methyldopa 500 mg/8 hours, nifedipine 10 mg/8 hours, vitamin C 50 mg/12 hours, KSR 1 tablet/8 hours, PRC transfusion 1 colf and the patient was transferred to a regular ward.

Figure 4. Ultrasound examination on the third day. IVC diameter (+)1.5 cm, collapsibility > 50%.

3. Discussion

Pulmonary edema (PE) is caused by leakage of intravascular fluid into the pulmonary interstitium and eventually into the alveoli. Acute pulmonary edema can be caused by increased capillary pressure (hydrostatic or cardiogenic pulmonary edema) or by increased capillary permeability. Cardiogenic pulmonary edema is characterized by dyspnea, tachypnea, and signs of sympathetic nervous system activation (hypertension, tachycardia, diaphoresis) that are often more pronounced than that seen in patients with increased permeability (noncardiogenic) pulmonary edema. In this patient, the presence of dyspnea, tachypnea, hypertension, and tachycardia supports the presence of cardiogenic pulmonary edema. Pulmonary edema is one of the signs of severe pre-eclampsia. After surgery, the patient was admitted to the ICU for further management of acute pulmonary edema and other possible complications. Mechanical ventilation with intubation has become the standard of care for severe respiratory failure. Mechanical ventilation was adjusted according to the protocol for protective pulmonary ventilation.7-10

The usefulness of the inferior vena cava collapsibility index (IVC-CI) as a substitute measure of volume status is still a topic of discussion in the literature. The inferior vena cava (IVC) is very flexible, so its size and movement change depending on the central venous pressure (CVP). When there is no blockage in the vena cava, CVP is the same as right atrial pressure (RAP). When you breathe normally, the pressure in your chest drops. This lets more blood flow into your right atrium, which then makes the inferior vena cava smaller. When the central venous pressure (CVP) rises, like when you breathe out or when your body has a positive fluid balance, the flow of blood in the vena cava slows down, and the diameter of the inferior vena cava (IVC) gets bigger. An invasive monitoring method that involves putting in a central venous catheter is generally thought to be the best way to test RAP. However, ultrasound (US) provides a non-invasive and more readily available alternative. Several studies have shown a strong association between the collapsibility of the inferior vena cava (IVC) and right atrial pressure (RAP). The diagnostic precision of IVC-CI is enhanced by employing predetermined threshold values that identify RAP as either high or low. Nevertheless, it is still uncertain whether IVC-CI can accurately forecast fluid response in hypovolemic patients.11-16 Further studies in a large population should be investigated for the accuracy of these diagnostic methods.
4. Conclusion

Acute pulmonary edema requires proper management to get a good outcome. Ultrasound measurement of IVC can be used to assess fluid volume status in pulmonary oedema. Measurement of the diameter of the inferior vena cava (IVC) can also be used to assess fluid volume status.

5. References


bradycardia during spinal anesthesia in spontaneously breathing patients during elective knee joint replacement surgery. Medicina. 2018; 54: 49.
