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## Successful recording perioperative hemodynamic changes with the severe right diaphragmatic hernia



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### ABSTRACT

We experienced a case of severe congenital diaphragmatic hernia (CDH) with severe deleterious hypoxemia after birth in which we succeeded in saving the patient with radical surgery. Observation of the patient's detailed hemodynamics was possible for the entire perioperative period. The central venous pressure (CVP) was high according to the pressure in the liver. The CVP subsequently decreased after the operation, and the oxygen saturation increased. Therefore, the cardiac diastolic disorder improved. This case suggests that the diastolic dysfunction in severe CDH patients is worsened by compression from herniated visceral organs.

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Right congenital diaphragmatic hernia (RCDH) is associated with the intrathoracic liver ("liver up"). Therefore, patients with RCDH are more seriously ill than those with left diaphragmatic hernia [1]. We experienced a case of severe RCDH with severe deleterious hypoxemia after birth and were able to record the hemodynamic changes in the perioperative period.

### 1. Case report

A 27-year-old mother was referred to our hospital at 26 weeks' gestation because of RCDH. Fetal echocardiography showed a lung/thorax transverse area ratio of 0.05 and an observed/expected the lung-to-head ratio of 18%, with an eviscerated structure of the liver and small and large intestines at a gestational age of 27 weeks (Fig. 1A). The infant was born via a planned cesarean section at 36 weeks.

We administered artificial respiration immediately after birth. However, the oxygenation was poor, with a preductal oxygen saturation of 70% and preductal PaO<sub>2</sub> of 38.7 mm Hg.

The left ventricular end diastolic dimension was 11 mm (67% of normal), and the left ventricular ejection fraction was 37% on echocardiography. The isovolumic relaxation time (IRT) was extended remarkably at 74 ms (Fig. 1B).

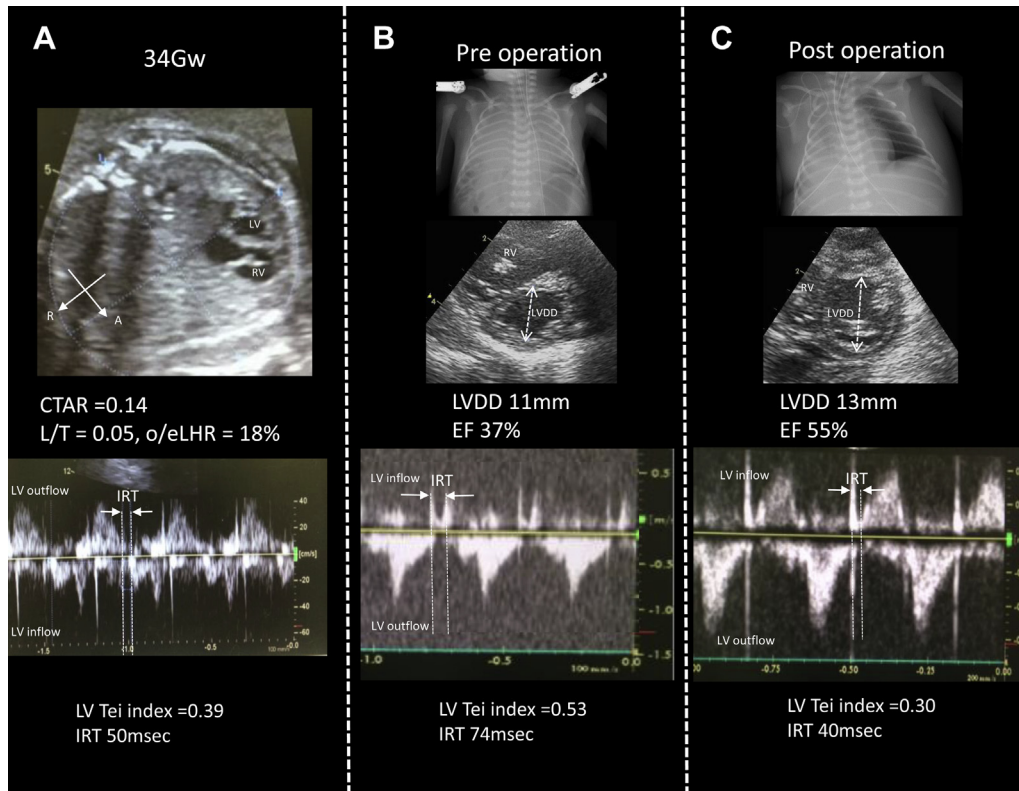
Although surfactant administration, nitric oxide inhalation and the continuous infusion of intravenous prostaglandin I<sub>2</sub> were provided, oxygenation remained low and the systemic blood pressure decreased to less than 40 mm Hg. On the other hand, the right jugular central venous pressure (CVP) was high at a mean level of 10 mm Hg (Fig. 2).

We considered that the patient's systemic and pulmonary circulation disorders were therefore affected by the pressure in the liver and therefore decided to perform radical surgery at 3 h after birth. When we began laparotomy to return the eviscerated structure to the abdominal cavity, CVP decreased from an average of 10 mm Hg to 3 mm Hg. Moreover, the preductal oxygen saturation increased from 65% to 90%, and the PaO<sub>2</sub> increased from 29.4 to 55.6 mm Hg (Fig. 2). The eviscerated structure included the liver and the entire small intestine, colon, and duodenum. The defect was closed with a patch. We were able to restore the diaphragm, however, oxygen saturation decreased when we closed the abdominal wall. Therefore, we did not sew up the abdominal muscle, and the surgery was completed.

On postoperative echocardiography, the LVDD increased to 13 mm (100% of normal), the IRT was shortened to 40 ms and

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**Fig. 1.** Results of echocardiography. Gw; gestational week, A; anterior, R; right, LV; left ventricle, RV; right ventricle, CTAR; cardio-thoracic area ratio, LVDD; left ventricular diastolic diameter, EF; ejection fraction, IRT; isovolumic relaxation time. (A) 34 gestational weeks. In four chamber view, heart sifted for right side. The heart was small at CTAR 0.14 Doppler echocardiography showed IRT was 50 ms and Tei index was 0.39. (B) Just after birth, chest roentgen was not showed the pneumatization. Echocardiogram showed LVDD was 11 mm, and EF was reduced at 37%. Doppler echocardiography showed IRT was prolonged at 74 ms and Tei index was worsen 0.53. (C) After operation, chest roentgen was showed the pneumatization at left side. Echocardiogram showed LVDD was bigger at 13 mm, and EF was increased at 55%. Doppler echocardiography showed IRT was shorten at 40 ms and Tei index was increased 0.3.

the ejection fraction of the left ventricle improved to 55% (Fig. 1C).

The prostaglandin  $I_2$  infusion was stopped three days after the operation. Meanwhile, the patient was switched from high-frequency oscillatory ventilation to synchronized intermittent mandatory ventilation six days after the operation, and NO was discontinued seven days after the operation. Artificial respiration was also discontinued 27 days after the operation.

## 2. Discussion

Severe diaphragmatic hernia is thought to adversely affect the cardiac function.

It has been reported that diastolic disorders in particular are important [2].

Increased pressure associated with the eviscerated organs and a rise in the left atrial pressure caused by compression from the left atrium are regarded as causes of diastolic disorders [3].

The mean CVP in cases of left CDH which we experienced to date is 7–8 mm Hg, a high level [2]. The mean CVP in the present case was 10 mm Hg with high level more. We speculate that the high CVP was caused by the need to maintain systemic circulation following the large infusion; namely, the higher CVP was necessary because the ventricular diastolic blood pressure had become

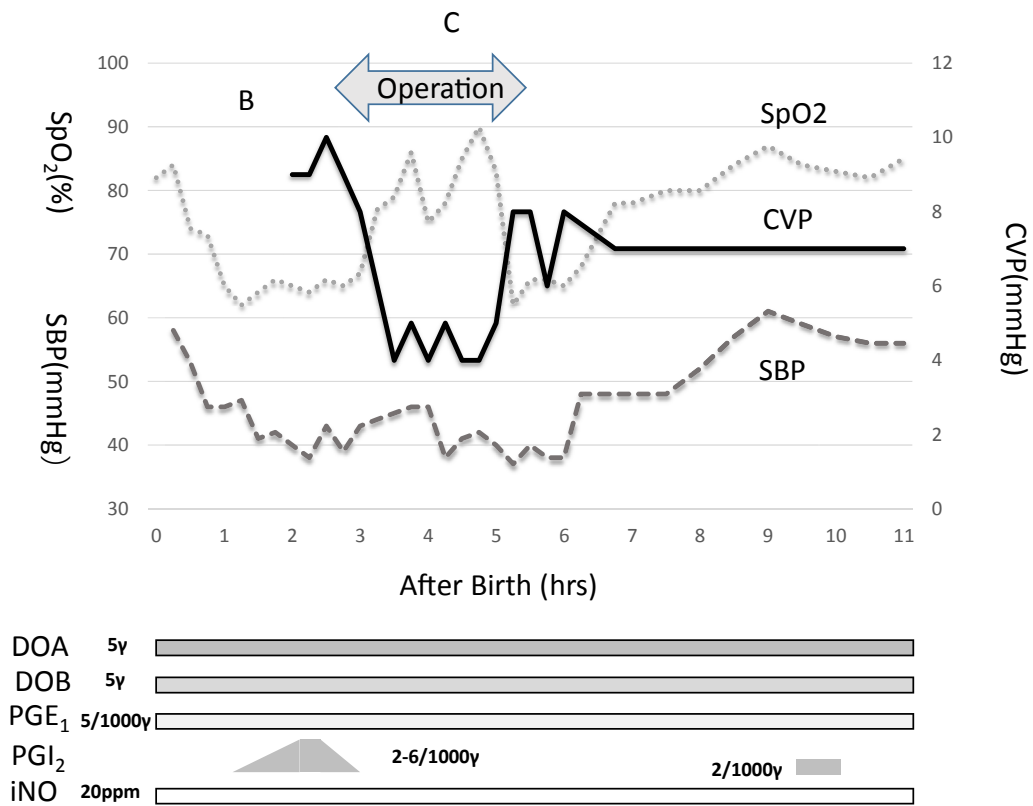
elevated. Whereas we cannot measure left atrial pressure. To measure left atrial pressure, Swan-Ganz catheter were needed. I think that the left atrial pressure and the right atrium pressure were equal in present case. This is because the echocardiography showed foramen ovale was widely.

Extension of IRT was shown on echocardiography in this case.

The CVP in the present case suddenly decreased after open surgery, while the oxygen saturation increased at the same time. Moreover, the patient's blood pressure increased after the operation, and an improvement in IRT was observed on echocardiography. Because the pressure in the liver disappeared, and the lungs were able to expand, thus improving the oxygen saturation. In cases of an increasing pulmonary blood flow, the increased preload to the left ventricle improves the cardiac function. Namely, this observation means that the recovery of the lung function precedes the improvement in the cardiac function. Finally the point at issue of this manuscript is perioperative hemodynamic record not the effectiveness of the early surgery.

## 3. Conclusion

CVP and the echocardiographic findings in this case suggests that the diastolic dysfunction in severe CDH patients is worsen by compression from herniated visceral organs.



**Fig. 2.** Clinical course in the perioperative period. SpO<sub>2</sub>; oxygen saturation measured with pulse oximetry, SBP; systolic blood pressure, CVP; central venous pressure, PGE<sub>1</sub>; prostaglandin E<sub>1</sub>, PGI<sub>2</sub>; prostaglandin I<sub>2</sub>, iNO; inhalation of nitric oxide.

**Conflict of interest**

The authors declare they have no potential conflict of interest.

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