PJSS Vol. 74, No. 2, July-December, 2019

PJSS PHILIPPINE JOURNAL OF SURGICAL SPECIALTIES

Use of Low Pressure Pneumothorax During Thoracoscopic Repair of a Pediatric Congenital Diaphragmatic Hernia: A Case Report

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Reported here is the case of a 6 year old male child with a left Congenital Diaphragmatic Hernia who underwent thoracoscopic repair. The use of continuous low pressure CO_2 insufflation pneumothorax during the procedure not only made manipulation during the reduction of bowel contents back into the abdomen easier, but also facilitated repair of the defect as it maintained bowel reduction during suturing. Although prolonged CO_2 has been hypothesized to be hazardous leading to hypercapnea and aggravating pulmonary hypertension in Congenital Diaphragmatic Hernia patients. The authors found it to be a safe modification of the technique as long as pre-operative planning, patient selection and intra-operative maneuvers were proprely performed.

Key words: Hernias, diaphragmatic, congenital; Pnumothorax; child

According to a large European register-based study, the reported incidence of Congenital Diaphragmatic Hernia (CDH) is 2.3 cases per 10,000 live births.[1] Whereas, a similar American study reported an incidence of 1.93 cases per 10,000 live births.[2] CDH is a rare congenital abnormality associated with a defect in the diaphragm closely associated with pulmonary hypoplasia and pulmonary hypertension. Most common is the posterolateral defect (Bochdaleck). It can be unilateral or bilateral, isolated or syndromic and is associated with high mortality rates.[3] Thoracoscopic repair has been proven to be a safe approach in the treatment of CDH, using 3 trocars in the chest using Carbon Dioxide (CO_2) insufflations of 4-6mm Hg popularized by Liem.[4] Single or double lung ventilation can be used during the repair and insufflation of the chest helps in the easier reduction of bowels back into the abdomen. Once the bowel has been reduced, insufflation can be stopped and the diaphragm can be repaired with interrupted non-absorbable sutures tied either intra or extracorporeal.

In this case report, the authors highlight a variation of the technique where they used continuous chest insufflation while closing the diaphragm.

The Case

A 6 year old male child was referred to WVMC due to a history of an on-and-off cough of a few months duration. The patient was initially seen by a pediatrician who requested chest radiographs (Figure 1) and treated the patient with antibiotics. The radiographs show bowel loops in the left chest; an impression of congenital diaphragmatic hernia was made.

Physical examination during admission showed a non-tachypneic, comfortable and active child. On auscultation, bowel sounds were appreciated in the left chest; there were no cardiac murmurs. Abdomen was slightly scaphoid, soft and non-tender. A chest CT scan done to outline anatomy showed a collapsed left lung, with incarcerated bowels and spleen (Figure 2). Complete blood count, baseline electrolytes and blood gases were within normal limits. Patient was co-management with the Pediatric Pulmonology Service. After pre-operative discussion and planning, the patient was scheduled for thoracoscopic repair of the CDH.

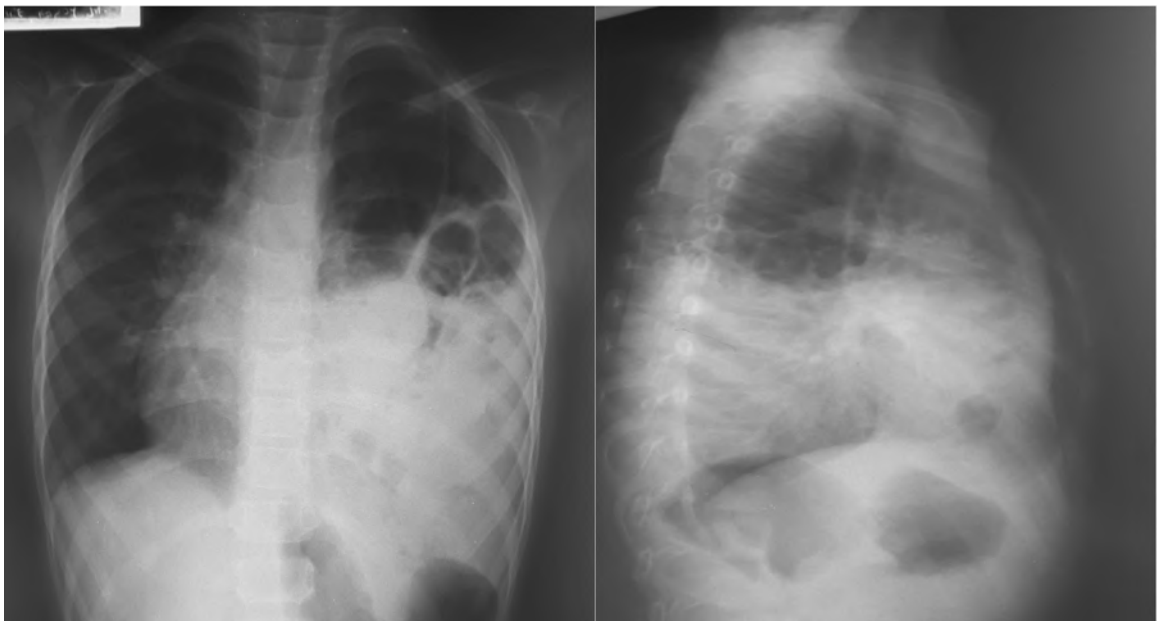

Figure 1. Chest radiograph of the 6 year old patient showing bowel loops in the left hemithorax.

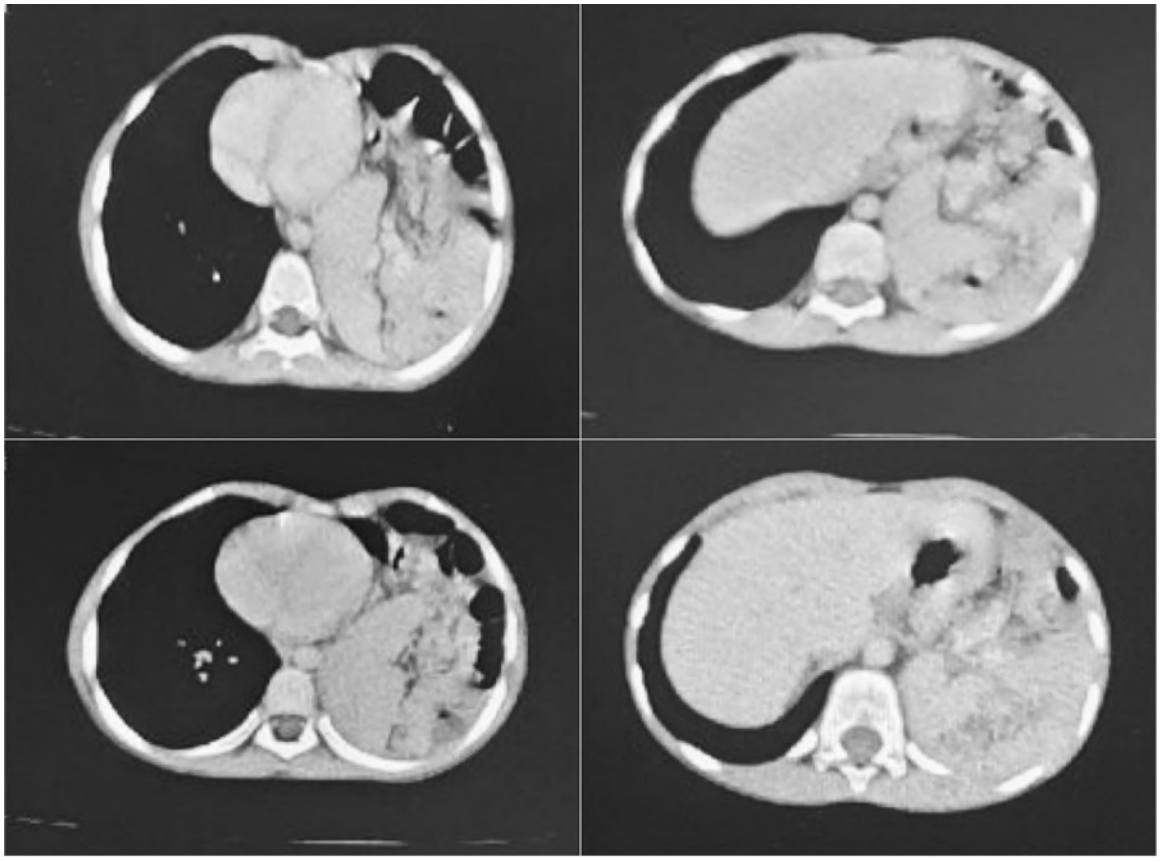

Figure 2. CT scan of the 6 year old male showing collapsed left lung, with note of bowels and spleen in the chest.

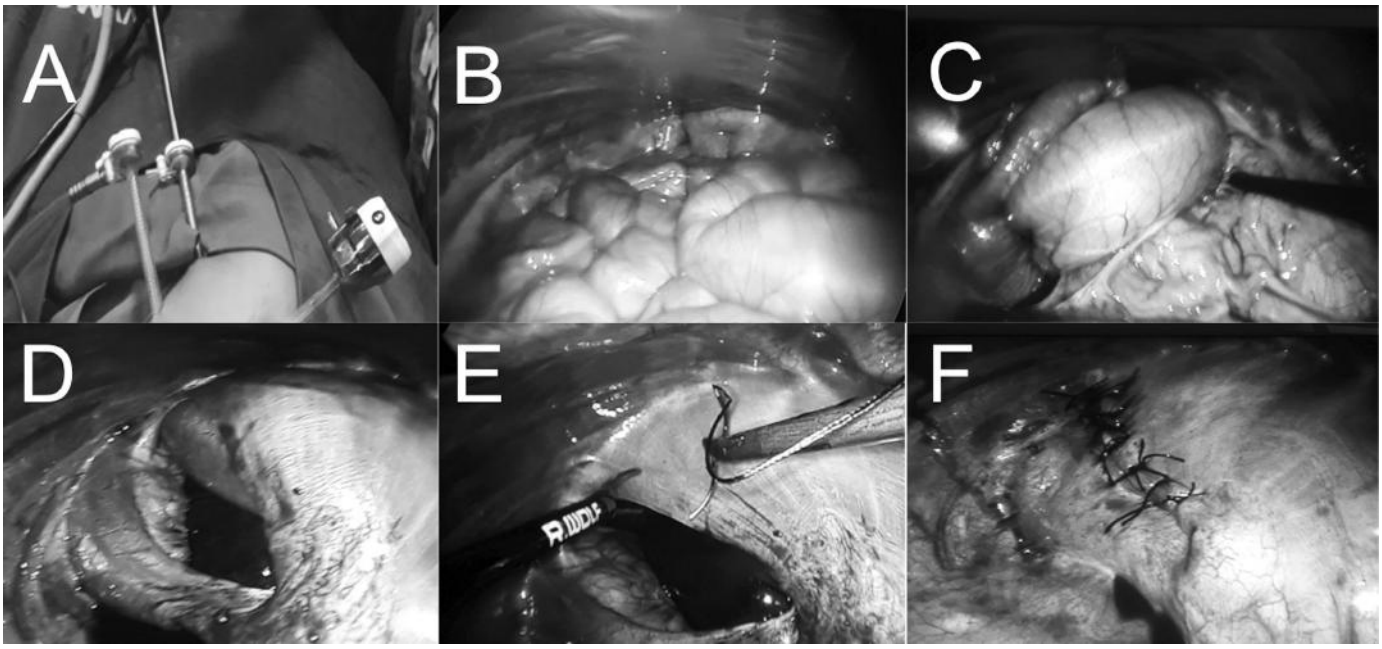

Figure 3. A. Trocar placement B. Thoracoscopic inspection showing the bowels in the chest. C. Reduction of contents back into the abdomen. D. Posterolateral defect after contents fully reduced back in the abdomen. E. Suturing of the defect. F. Defect closed.

Patient was placed in right lateral decubitus position using single lung ventilation with optical 5mm trocar in the left 3rd intercostal space (ICS) and two working ports both at the left 5th ICS at the anterior axillary line and just at the tip of the scapula. Upon inspection the thorax, the bowels and spleen were noted. CO_2 insufflation was maintained at 4-6 mmHg throughout the procedure. Reduction was technically easier as the pneumothorax helped in the return of the viscera back in the abdomen. CO_2 was monitored with a capnograph and levels remained normal (35 to 45 mmHg) through out the procedure. The 4 cm x 2 cm posterolateral diaphragmatic defect was repaired using interrupted silk 2/0 intracorporeal sutures.

A chest drain was placed through one of the working ports. Total procedure time was 62 minutes (Figure 3). Chest drain was removed on the first operative day and chest X-ray on the 2nd post-operative day showed a fully expanded left lung (Figure 4). Patient was then subsequently discharged with minimal post-operative pain.

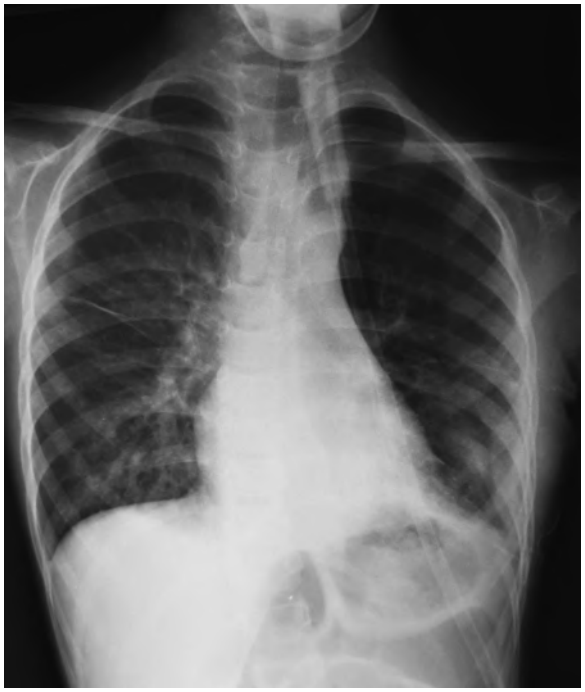

Figure 4. Post-operative chest radiograph

Discussion

Minimally Invasive Surgery (MIS) is accepted as a better alternative to the conventional subcostal approach to the repair of CDH in older children. It offers less pain and incisional complications, avoids thoracotomy-related sequelae, and reduces of surgical stress. But the role of thoracoscopy in the neonate is controversial as some studies suggest that it could result in higher recurrence rates.[6] As technology further advances, the authors can better determine the role of MIS in this subset of patients. WVMC offers MIS to stable patients who do not have life-threatening comorbidities. Patients unable to qualify for MIS undergo traditional open surgery. Surgery in the neonate has been particularly challenging because of the unique patient physiology.

There has been a debate on which MIS approach in the repair of CDH repair, either laparoscopy or throracoscopy is superior. The benefits of laparoscopy are the possibility of an examination of the abdominal contents, a secure suturing without risk of visceral injury, and an easy conversion if needed. However, the laparoscopic approach is hampered by a limited working space and a lack of vision after reduction. It also requires sustained CO_2 insufflation.[7] Together with the other authors[3,4,7], they have found thoracoscopy much easier as it affords better visualization during the repair of the defect.

The authors' use of continuous CO_2 insufflation is a slight modification of the procedure as popularized by Liem.[5] Continuous insufflation prevents bowel from reentering the thorax during suturing; avoiding inadvertent bowel injury. The authors did not encounter any physiologic derangements associated with prolonged CO_2 insufflation such as hypercapnia and respiratory acidosis contrary to what has been reported in the literature.[5]

In the course of the surgery for this patient, the authors did not find any detrimental effects of prolonged CO_2 as long as pressure was maintained between 4-6mmHg. It is hypothesized that prolonged CO_2 insufflation can rapidly worsen the respiratory and hemodynamic conditions in CDH patients which lead to increasing partial pressure of CO_2 levels, pulmonary acidosis, hypoxemia and pulmonary hypertension.[4,7] The importance of proper patient selection and pre-operative preparation when subjecting patients to MIS cannot be over emphasized. During surgery, PCO_2 levels must be maintained within normal limits. If rising PCO_2 levels are encountered, a reduction in CO_2 pressure and flow rate is needed and any anesthetic and physiologic concerns must be addressed. Conversion to an open procedure will be necessary if the MIS procedure is deemed unsafe.

Conclusion

Thoracoscopy is a safe procedure for CDH patients. Continuous chest insufflation during repair can provide with an added advantage of keeping the bowels in the abdomen during suturing and the defect preventing inadvertent bowel injury. Proper patient selection should be of primary concern to the surgeon in performing MIS procedures in the pediatric age group.

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