

Diaphragmatic Eventration After Chest Tube Placement In A Neonate: Report Of A Case And A Review of the Literature

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Abstract:

Unilateral and reversible paralysis of the diaphragm due to phrenic nerve injury is a very uncommon and unexpected complication in the course of a chest tube placement, especially in neonates. Insertion of the chest tube can cause injury to the intra-thoracic segment of the phrenic nerve which runs close to the mediastinal pleura. Only few cases of diaphragmatic paralysis due to chest tube placement in neonates have been reported in the literature. We report a case of reversible iatrogenic right diaphragmatic paralysis following the placement or manipulation of a chest tube in a neonate, operated for oesophageal atresia and distal tracheo-esophageal fistula.

Keywords: Eventration of diaphragm, phrenic nerve, chest tube.

Case Report

A 4-days-old female infant was transferred to Pediatric Intensive Care Unit (PICU), with the diagnosis of oesophageal atresia with tracheo-oesophageal fistula. She was born by a Caesarian section at a gestational age of 34 weeks with apgar score of 5 at 1 minute and 10 at 3 minutes. She weighed 2.0 kg at birth. She was found to have increased oral secretion with slight abdominal distention. Nursing staff failed to pass a nasogastric tube and the chest x-ray showed coiled nasogastric tube in the upper pouch of oesophagus, air in stomach and intestines and normal diaphragm. On physical examination, no other congenital abnormalities could be detected.

At exploration via right thoracotomy through the fourth intercostal space, with extra-pleural approach, the tracheo-oesophageal fistula was found just above the carina and the distance between upper and lower pouch was very short. The tracheo-oesophageal fistula was divided and repaired. Minimal dissection of upper pouch was needed to do tensionless primary anastomosis of oesophagus. A right-sided chest drain was inserted and connected to underwater seal. The child was send back to PICU ventilated. Child developed right pneumothorax 4 hours after surgery (Fig 1). A second chest tube was inserted anterior to the first chest tube but failed to resolve the pneumothorax so it was removed and a third chest tube was inserted from a separate space but this chest tube also did not work. It was manipulated three times by three different doctors without any success. An angiocath was inserted more anteriorly and connected to the Hemlich valve, this resolve the pnemothorax completely. Angiocath was removed after 24 hours. Child was extubated on the fifth post operative day.

Sixth post operative day contrast swallow showed an intact anastomosis with no leakage or stenosis. Chest tube was removed and x-ray chest done, which revealed elevation of right diaphragm, suggestive of a right phrenic nerve palsy (Fig. 2). Chest fluroscopy screening confirmed the presence of paradoxical movement of the right diaphragm.

A diagnosis of right eventration of diaphragm due to right phrenic nerve injury was made and as the child was asymptomatic, we decided to manage it conservatively. She was on minimal amount of oxygen by nasal canula (0.1 L/ minute of oxygen) and was maintaning good oxygen saturation on room air. Gradually, she was weaned off from oxygen. She was kept under observation. She remained asymptomatic. At 3 months follow-up, she is doing well. No respiratory problems, gaining weight. X-ray showed much improvement (Fig. 3).

Discussion:

Diaphragmatic eventration due to phrenic nerve injury secondary to chest tube placement or manipulation is very rare. However, phrenic nerve injury resulting in diaphragmatic eventration is not an uncommon complication of iatrogenic operations, particularly cardio-thoracic surgery. In Mickell's series of 1981 cardiac cases, the overall incidence of phrenic nerve palsy was 1.71%.¹ Eventration of diaphragm may be either 1) congenital (non-paralytic) which is a developmental abnormality characterized by muscular aplasia, 2) acquired, which is due to phrenic nerve injury. Iatrogenic phrenic nerve injury in the neonate has most commonly been reported following birth trauma² and operative intra-thoracic.^{1,3} On the right side, the phrenic nerve after entering the thorax behind the subclavian vein, runs in the mediastinum anterior to the pulmonary hilum and then down on the pericardium to the diaphragm. Its course in the thorax is very anterior relative to oesophagus. It is very difficult to see or damage the phrenic nerve, while repairing the very short gap oesophageal atresia with TOF in posterior mediastinum. Right phrenic nerve injury can occur in the repair of high tracheo-oesophageal fistula and a high upper pouch due to dissection or retraction near the apex of the thorax.⁴

We believe that the mechanism of phrenic nerve damage in our patient is the result of trauma caused by chest tube insertions or manipulations. It is very unlikely that phrenic nerve was injured during our repair of oesophageal atresia, as the gap between upper and lower pouch was very short and a minimal dissection was needed to mobilize the upper pouch for end-to-end primary anastomosis. There was no dissection or retraction near the apex of the thorax.

We have found only one previous report of reversible phrenic nerve injury due to chest tube insertion in a neonate.⁵ In this case left phrenic nerve was injured secondary to the insertion of chest tube for the left tension pneumothorax in a 9-hour-old child, resulting in the eventration of left diaphragm. This eventration was temporary and resolved spontaneously over 6-10 weeks by conservative management. Ayalon et al.⁶ and Phillip et al.⁷ have reported one case each of right eventration of diaphragm in neonate due to injury of right phrenic nerve by chest tube. In these cases, injury to the nerve was irreversible and both the child required surgical plication of right diaphragm. The severity of phrenic nerve damage normally determines the likelihood of recovery. Sedden's⁸ conceptual description of nerve injury can be helpful. Neurotmesis is the state of nerve that has been either severed or seriously disorganized while maintaining an external appearance of integrity. Axonotmesis is characterized by interruption of the axons and their myelin sheath while the stroma retain anatomic continuity. Neuropraxia is the reversible damage to the nerve in which there is no degeneration of axons. Blunt trauma from chest tube insertion or manipulation can cause phrenic nerve injury either reversible or irreversible. The natural history of traumatic paralysis suggest spontaneous recovery in 50-80% of cases by age of one year.^{9,10} Continuous positive airway pressure may depress the affected diaphragm towards the normal position and obscure the diagnosis as demonstrated in our patient.

Diaphragmatic paralysis may result in respiratory insufficiency and considerably increases the post operative morbidity, particularly in neonates and small infants.

Management of eventration of diaphragm secondary to phrenic nerve injury must be individualized and depends on the incapacity of the individual. Controversy still exists regarding conservative versus surgical treatment of diaphragmatic eventration. When phrenic nerve paralysis is thought to be potentially reversible and the patient is asymptomatic, it may be managed conservatively as in our case. It may require ventilatory support in the form of Constant Positive Air-way Pressure (CPAP) or Intermittent Positive Pressure Ventillation (IPPV) and Positive End Expiratory Pressure (PEEP).⁷

In conclusion, our case illustrates that a reversible hemidiaphragmatic palsy may occur as a consequence of chest tube insertion or manipulation and we believe that this experience underlines the importance of scrupulous attention to chest tube placement in neonates as diaphragmatic paralysis may be life-threatening complication in neonates.

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Legend:

- Fig. 1 : Post operative chest x-ray showing right pneumothorax. Heart and mediastinal structures are shifted to left.
- Fig. 2 : Follow-up x-ray after removal of chest tubes. It shows satisfactory re-expansion of right lung, however, right hemidiaphragm appeared high in position.
- Fig. 3 : Three months follow-up x-ray. Shows satisfactory aeration of both lung fields with improvement of the position of right hemidiaphragm.