CASE REPORT

Phrenic Nerve Injury Is a Differential Diagnosis of Hypoxemia after Video-Assisted Thoracoscopic Thymectomy: 2 Cases Report and Literature Review

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Abstract Hypoxemia after general anesthesia is not uncommon. For patients after thoracotomy, the differential diagnosis is usually difficult. Surgical, anesthetic, and patient-associated factors may contribute to postoperative hypoxemia. We described two patients who underwent video-assisted thoracoscopic thymectomy and developed hypoxemia immediately after extubation. Phrenic nerve injury was suspected in both patients. One case recovered spontaneously without intervention. The second case who had been demonstrated as bilateral phrenic nerve injury after the operation was continuously on ventilator after physical therapy and respiratory training for 2 months.

HYPOXEMIA after general anesthesia is not uncommon. Atelectasis, reduced functional residual capacity, respiratory depression from the residual effect of anesthetic drugs, hypoventilation, V/Q mismatch and pulmonary shunt may all contribute to impaired respiratory function postoperatively. It usually requires immediate differential diagnosis and intervention. We described two patients who underwent video-assisted thoracoscopic thymectomy but developed hypoxemia immediately after extubation.

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CASE DESCRIPTION

Case 1

A 62-year-old female patient was scheduled for thymectomy using video-assisted thoracoscopy. She had no obvious symptom and no significant medical history. Chest computed tomography (CT) showed a well-defined mass in anterior mediastinum with 20 mmx16 mm in size. The diagnosis of Myasthenia Gravis was excluded preoperatively. The tumor and thymus was successfully excised, and a right thoracic tube was inserted before closing incision. Residual muscular block was antagonized by neostigmine and atropine. The patient was extubated when she was fully awake, being able to respond to verbal commands, spontaneous respiration resumed with the

tidal volume between 250-300 ml and the frequency between 16-20/min. After extubation, the blood oxygen saturation of the patient decreased below 90% quickly on air and increased to 90% and above slowly on 100% oxygen by mask. Ultrasound showed no movement of right diaphragm and mildly decreased movement of left diaphragm. The patient was transferred to post anesthesia care unit (PACU) for further monitoring. When her blood oxygen saturation was able to maintain above 90% on air for 2 hours after the extubation, she was sent back to the ward. Her chest X-ray on the second postoperative day did not show elevation of diaphragm. Transient paralysis of phrenic nerve was suspected in this case.

Case 2

A 53-year-old male patient underwent video-assisted cystectomy for the treatment of thymic cyst. He had a history of hypertension, well controlled with Bisoprolol and Felodipine. Preoperative chest CT showed left anterior mediastinal cyst with transection size of 1.5 cm × 2.7 cm. The thymic cyst was successfully excised. The patient was fully awake after the operation and extubated when resuming spontaneous respiration. He developed dyspnea and shortness of breath in PACU. His blood oxygen saturation couldn't maintain 90% and above using nonrebreather bag with FiO_2 of 100%, and arterial blood gas showed PaO_2 55 mmHg. Paradoxical breathing was noticed, and ultrasound showed no movement of bilateral diaphragm (**Figure 1**). The bedside chest X-ray showed elevation of bilateral diaphragm and atelectasis (**Figure 2**). He was reintubated and transferred to ICU. Bilateral phrenic nerve injury was suspected. The patient was put on a ventilator postoperatively and failed of extubation. Tracheostomy was performed, but he was still on ventilator after physical therapy and respiratory training for 2 months. The patient was transferred to rehabilitation hospital for further recovery.

DISCUSSION

Postoperative hypoxemia is usually challenging, especially in patients undergoing thoracic surgeries. Differential diagnosis is important. In this article, we described two cases of postoperative hypoxemia in early postoperative period after thoracic surgeries. One was suspected as transient phrenic nerve injury

Figure 1. M mode sonography of a 53-year-old male after video-assisted thymic cystectomy. No respiratory movement of diaphragms was observed, indicating paralyzed diaphragms.

Figure 2. Bedside chest X-ray film of a 53-year-old male after video-assisted thymic cystectomy. Elevation of bilateral diaphragm and atelectasis were noted.

and one was diagnosed as bilateral phrenic nerve injury.

Phrenic nerve injury is a rare complication after thoracic surgeries. Tumor invasion, thermal injuries during dissection by electric cut, intraoperative stretch or laceration could be the possible mechanisms. Injury of left phrenic nerve is more common due to its longer length than the right one.^[1,2] The incidence as reported was between 2%-7%,^[3,4] and prognosis of phrenic nerve injury after thoracic surgery is usually poor.^[5]

The diagnosis is usually difficult since its clinical manifestation is non-specific, varying from asymptomatic radiographic abnormality to severe pulmonary dysfunction with prolonged mechanical ventilation. Residual neuromuscular block can lead to decreased movement of diaphragm. Patients may have impaired

pulmonary function preoperatively or have transient decrease of pulmonary function after thoracotomy. All these factors may co-exist during early postoperative period, making differential diagnoses difficult. Failure to wean from ventilator, elevation of diaphragm on chest X-ray and paradoxical movement of abdomen during spontaneous respiration^[6] after the operation may suggest the diagnosis.

Most unilateral phrenic nerve injury was asymptomatic. However unilateral phrenic nerve palsy may lead to a significant impairment of dynamic lung volumes in early postoperative period.^[7] In patients who have diseases with impaired pulmonary function, such as chronic obstructive pulmonary disease, even unilateral phrenic nerve injury may lead to postoperative pulmonary complications. Bilateral phrenic nerve injury, although rare, is associated with aggravated respiratory distress and prolonged mechanical ventilation.

Fluoroscopy,^[8] ultrasound^[9,10] and electrophysiological examination^[10] can be used for assessing phrenic nerve injury. The electrophysiological test was reported as the golden method for the diagnosis of phrenic nerve injury^[11] with high sensitivity and specificity. However, it is not possible to access in operating room and at all hospitals, especially during early postoperative period. Ultrasound in evaluation of diaphragmatic movement has been proposed as a simple, non-invasive bedside method,^[9] and has been widely used in perioperative assessment of diaphragmatic function recently.^[12,13] The outcome varies from fully recovery to fatal conditions,^[8,9] and the recovery time varies from days to years. Treatment is usually not necessary for most patients with unilateral diaphragmatic paralysis. Respiratory exercise, diaphragm plication and phrenic nerve stimulation can be considered for patients with bilateral phrenic nerve injury.

In conclusion, although phrenic nerve injury after thoracic surgery is rare, our cases suggested that it should be considered as a possible reason for postoperative hypoxemia. In thoracic surgery, surgeons and anesthesiologists should fully recognize the proposed possibility. Phrenic nerve function should be monitored during surgical procedures for patients with huge thymic tumor or at high risk of injury.

Conflict of interests statement

All authors declare no conflicting interests.

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