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CASE REPORT

A rare postoperative complication of anterior lower thoracic instrumentation: diaphragmatic laceration with hemothorax

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Abstract
Purpose To highlight the importance of preventing visceral injury due to prominent anterior implants at the spinal column.
Methods A 52-year-old man with cord compression was treated with a T9/10 discectomy and instrumented fusion via a right thoracotomy and trans-pleural approach. Postoperatively, he had improved lower limb numbness. However, after a bout of coughing, there was sudden increase in chest drain output, hemodynamic instability and massive fluid collection in the right chest cavity.
Results Emergency re-exploration of the thoracotomy was performed and a 6 cm laceration of the right postero-medial diaphragm was identified as the bleeding source and was found to be in close proximity with the locking nut of the anterior implants. The laceration was repaired and a soft synthetic patch was used to cover the implants. Postoperatively, the hemothorax resolved and the patient recovered from the neurological deficit.
Conclusions Prevention of diaphragmatic injury can be performed using lower profile and less sharp-edged implants. Implant coverage with a soft synthetic material is necessary if unable to perform direct repair of the parietal pleura over the implants.

Keywords Hemothorax · Anterior spinal fusion · Diaphragm · Parietal pleura

Introduction

Spinal cord decompression by discectomy and instrumented fusion through a thoracotomy approach is a commonly used procedure [1, 2]. Postoperative spontaneous hemothorax is a known but rare complication after this transpleural approach to the thoracic spine [3–5]. It may be caused by re-bleeding of the epidural vessels, oozing from the exposed bone surfaces, inadvertent lung laceration or vascular injury. These causes are usually identified intraoperatively or in the immediate postoperative period. However, late presentation up to 10 months postoperatively has been reported due to the violation of inferior phrenic artery by the anterior instrumentation [4]. Delay in diagnosis of early hemothorax is unlikely because of obvious clinical manifestations like high chest drain output, hemodynamic instability and drop in hemoglobin level. A simple chest X-ray (CXR) can easily confirm the diagnosis of hemothorax.

We report a case of early spontaneous hemothorax caused by a diaphragmatic laceration from anterior instrumentation. This case report serves the purpose of reminding surgeons to identify and prevent potential visceral injury intraoperatively. This can be done by either using lower profile and less sharp-edged implants or covering the implants with soft synthetic material if the parietal pleura closure cannot provide adequate coverage of the implants. During exploration of a postoperative hemothorax, meticulous examination of the diaphragmatic surface opposing the implants is necessary to control the possible sources of hemorrhage.

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Case report

A 52-year-old man with history of thoracolumbar back pain for many years was admitted because of spontaneous onset of gradual lower limb weakness and numbness for three days. The right lower limb was 3/5 by Medical Research Council grading (MRC grading) whereas the left side remained 5/5. Sensory level was at T11 and the sensation in both lower limbs was affected. He also had unsustainable ankle clonus and up-going Babinski sign in the right lower limb. He did not have sphincter dysfunction and his anal tone was intact. X-ray examination of the thoracic and lumbar spine was unremarkable. MRI revealed T9/10 prolapsed intervertebral disc causing spinal cord compression with myelomalacic changes (Fig. 1).

Urgent anterior T9/10 discectomy and instrumented fusion was performed through a right T8 thoracotomy and trans-pleural approach. At the end of the surgery, the implants (Universal Spinal System Anterior, Synthes®) could only be covered partially by the parietal pleura due to the bulkiness of the implants and no additional mobilization of the parietal pleura. The thoracotomy was then repaired over one chest tube. The patient reported reduced numbness at lower limbs immediately after the surgery. No hemothorax was seen on plain chest radiograph CXR 6 h after the surgery (Fig. 2a, b) and the chest drain output was only 100 ml. He was hemodynamically stable at the time.

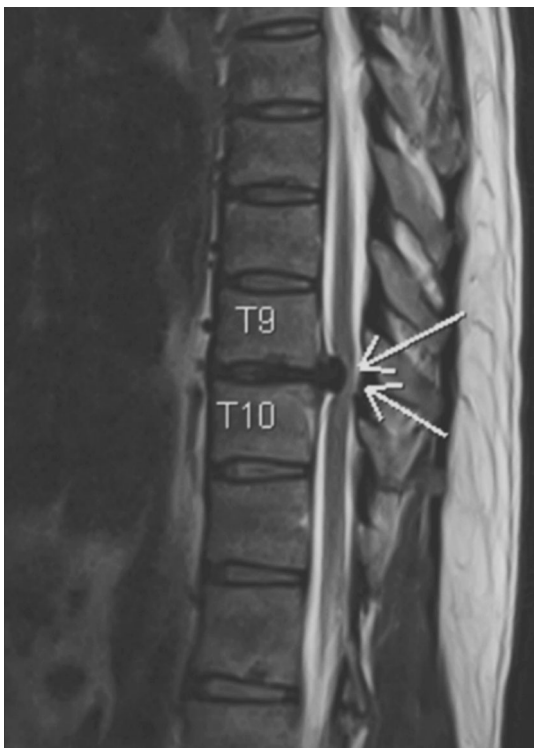

Fig. 1 Preoperative sagittal T2-weighted MRI showing a huge T9/10 prolapsed intervertebral disc causing spinal cord compression and myelomalacic changes of the spinal cord

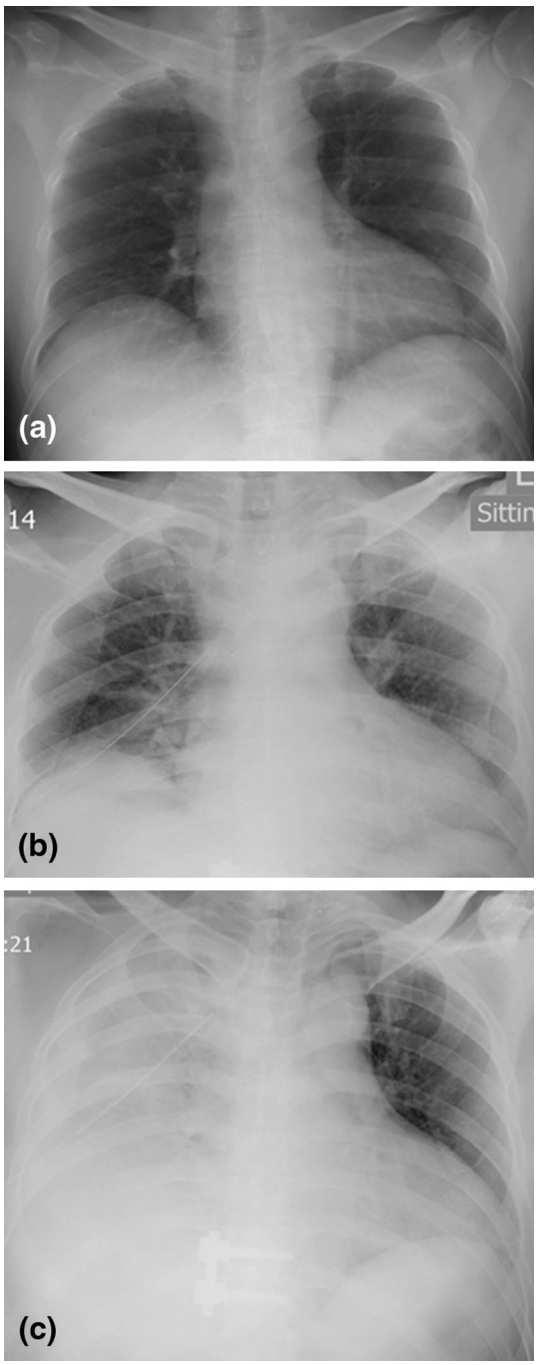

Fig. 2 Chest x-ray taken **a** preoperatively was clear. Subsequent X-rays taken after the T9/10 anterior decompression and instrumented fusion at **b** 6 h postoperatively showed no hemothorax but a massive right hemothorax was observed at **c** 14 h postoperatively

The patient subsequently coughed vigorously due to sputum retention and reported immediate retrosternal pain. Thereafter, the chest drain output increased to 1200 ml in 8 h and his blood pressure became labile. Repeat CXR 14 h after the initial operation showed significant fluid

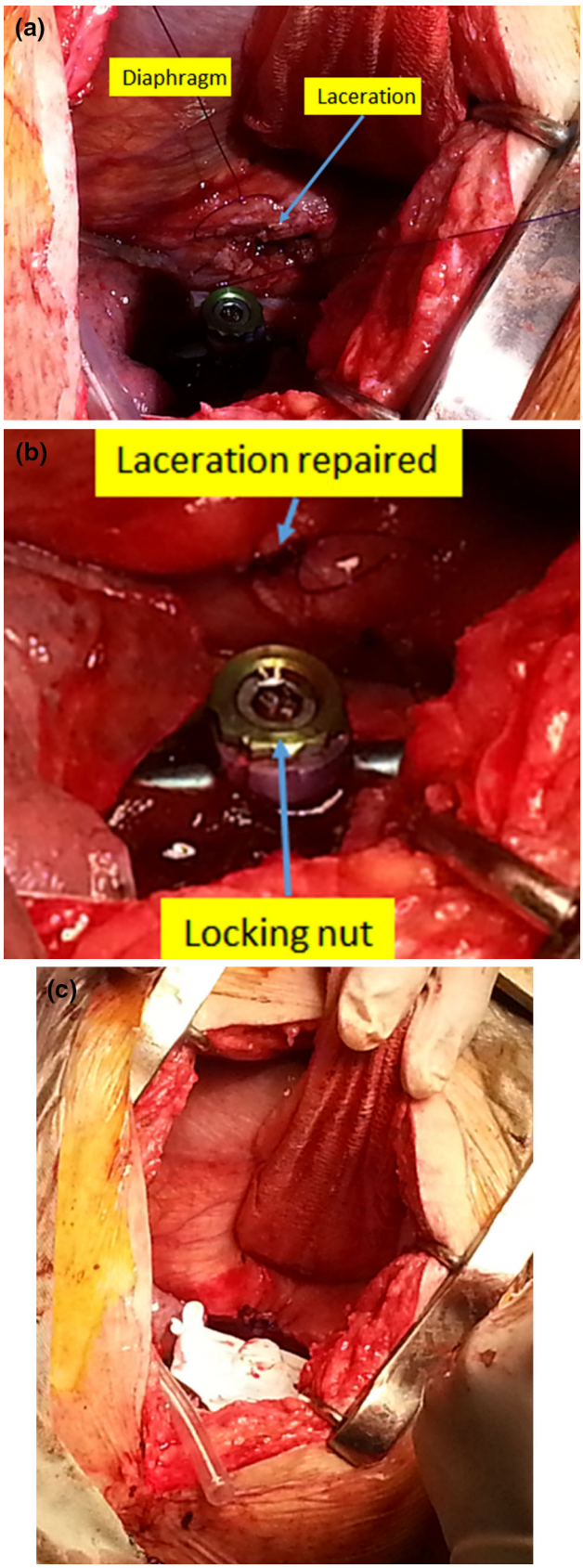

Fig. 3 Intraoperative photos of the reoperation showed **a** the diaphragmatic laceration opposite the locking nut of the screw. The laceration was repaired and **b** it was identified to be in close proximity of the sharp edge of the locking nut. **c** A synthetic material was used to provide adequate coverage the sharp locking nut

accumulation inside the right thorax (Fig. 2c). Together with the rapidity of onset following bouts of heavy coughing, hemothorax was highly suspicious. He was immediately taken back to the operating theater for re-exploration of the right thoracotomy. While re-opening the thoracotomy, the patient had hiccoughs despite general anesthesia. A right postero-medial diaphragmatic laceration of about 6 cm opposing the spinal implant was found with active bleeding (Fig. 3a, b). The laceration was repaired and the spinal implants were covered by a synthetic dural patch (Neuro-Patch®, Aesculap Inc.) to prevent any further laceration of the diaphragm (Fig. 3c). Old blood clots were removed from the pleural cavity and the thoracotomy was repaired over two chest tubes.

The subsequent chest drain output was not excessive and the chest tubes were removed on day 4 after the second surgery. CXR taken one week after the re-exploration revealed no recurrent hemothorax and the postoperative thoracic spine X-ray demonstrated satisfactory implant position (Fig. 4). The patient had near-full neurologic function two weeks after the spinal cord decompression and was able to walk independently without any aids.

Discussion

The diaphragm is a dome-shaped muscle that is important for respiration. During inspiration, the muscle contracts and the dome flattens. As a result, the intra-thoracic volume is increased and the intra-thoracic pressure is decreased, reducing the alveolar pressure below atmospheric pressure and allowing air entry into the lungs. During expiration, the diaphragmatic muscles relax and the dome shape is resumed. This increases the intra-thoracic pressure and air is expelled from the chest cavity. When the diaphragm is in its dome shape, the peripheral muscular part is in close proximity with the lower chest wall and the lower thoracic spine. During the coughing effort, the intra-thoracic pressure is greatly increased by the contraction of the abdominal muscles [6]. This increase in intra-abdominal pressure causes a rigorous upward thrusting of the diaphragm which expels the air out of the lungs in an effort to cough up sputum. Such violent upward thrust of the diaphragm induces a strong gliding movement between the lower thoracic spine and the diaphragm. Any hard prominent object in its path will impede this smooth gliding motion

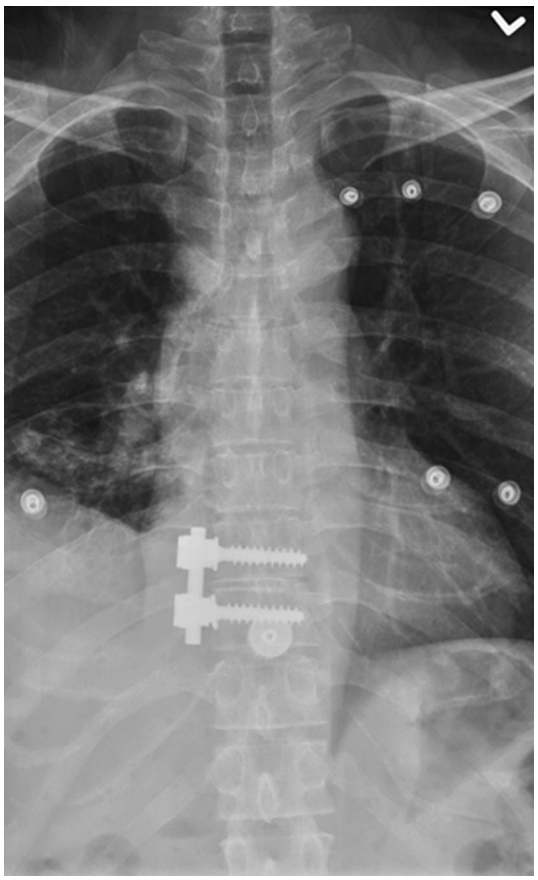

Fig. 4 Postoperative thoracic spine X-ray one week after the exploration showed satisfactory implant position and no hemothorax

and may even lacerate the diaphragm. Both hemi-diaphragms move across a few intercostal spaces within a single breathing cycle. The right hemi-diaphragm usually lies on a more rostral position due to the underlying liver. In addition, there are regional differences in the movement of the right hemi-diaphragm. The middle and posterior thirds of the right hemi-diaphragm have greater excursion than the anterior third [7]. As a result, the posterior part of the right hemi-diaphragm is prone to injury by prominent implants inserted in the lower thoracic spine.

Under normal circumstances, gliding movement within the pleural cavity has minimal friction due to the smooth surfaces between the parietal and visceral pleura as well as the lubricating pleural fluid [8]. Although it is desirable to repair the parietal pleura to provide a barrier between the implants and the pleural cavity, it is not always feasible due to the bulkiness of the implants and relative inelasticity of the pleura. Possible solutions include mobilizing a larger area of parietal pleura to close the pleural cavity over the implants or use a smooth synthetic patch to cover the implants. This avoids violation of the nearby lung or diaphragm by the edge of the implants. Furthermore, lower profile implants facilitate complete closure of the parietal pleura.

Due to the uncommon nature of this complication, the most appropriate synthetic material to cover the implants is unknown and beyond the scope of this report. However, this material should be non-absorbable, thick enough to provide a cushion effect for the implants and to hold suturing to the surrounding tissue. A watertight seal of the repair is likely unnecessary to prevent migration as scarring takes place approximately 2–3 weeks after repair and it can then remain as a permanent cushioning device for the implants.

Postoperative diaphragmatic laceration due to anterior lower thoracic spinal instrumentation has not been reported previously. Theoretically, instrumentation on the right side with chest tube insertion may be additional risk factors for the scenario presented in our case. On the right side, the liver may push the right hemi-diaphragm hard against the prominence of the lower thoracic implants. Hence, a left-sided approach may be safer. However, since the weakness of the patient was on the right side, right sided approach offered direct decompression. In addition, chest tube insertion often induces considerable pain during breathing. To minimize such pain, patients may use more diaphragmatic breathing and the diaphragm may rub against the implants more. Whether this postulation is true and makes patients more susceptible to diaphragmatic injury requires further study.

It is difficult to be completely sure whether the diaphragmatic laceration was not caused by other reasons such as intraoperative inadvertent injury. However, the circumstantial evidence and timing of the hemothorax supports our postulation. The early CXR did not reveal any hemothorax and the chest drain was minimal after surgery. Yet, subsequent to the patient's episode of vigorous cough and retrosternal pain, the hemodynamics became labile, chest drain output increased significantly and a massive hemothorax was detected in the following CXR. Furthermore, hiccough appeared during the re-exploration which indicates diaphragmatic irritation.

Some important considerations in our case require further discussion. There have been two reports of hemothorax caused by rib fractures similarly requiring surgical repair [9, 10]. However, these reports provide limited treatment pearls to the surgeon since rib fractures are commonly managed conservatively and thus no preventive measures can be implemented prior to the complication. This is unlike our report where specific technical considerations are required for choosing appropriate anterior implants and their coverage. The use of anterior implants is a relative indication in our case as some may consider a simple discectomy without instrumentation to be adequate for treatment of thoracic disc herniations [11]. However,

our decision for instrumented fusion in this one-level disease was to enhance the fusion rate, to minimize postoperative graft complications and to avoid the use of external bracing for protection. Nevertheless, the main message of this report regarding anterior instrumentation surgery is the importance of using low profile implants without sharp edges and to provide adequate implant coverage with either pleural repair or soft synthetic material. These technical pearls are applicable to all diagnoses requiring lower anterior thoracic surgery.

Conclusion

Surgeons should select low profile implants at the lower thoracic spine for the anterior instrumentation. Complete coverage of implants by repair of the parietal pleura is desirable. In case of incomplete coverage due to tight or friable parietal pleura, surgeons should consider using a smooth synthetic substance to cover the implants. A left-sided approach may be safer but the choice of approaching sides may be dictated by the pathology.

Compliance with ethical standards

Conflict of interest No funding received for this study.

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