

Clinical Studies

Phrenic nerve palsy after cervical laminectomy and fusion

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ABSTRACT

Background: Phrenic nerve palsy is a rare complication of cervical spine surgery. There are no previously reported cases of unilateral diaphragmatic paralysis following posterior cervical spine surgery. Here, we present a case of a 69 year-old Caucasian male with severe cervical stenosis with myelopathy who underwent posterior spinal instrumentation and fusion (PSIF) from C2 to T2, with laminectomies at C3-C7.

Outcome: The patient developed respiratory distress post-operatively and was found to have an elevated hemidiaphragm secondary to phrenic nerve palsy. He was treated with respiratory support, with significant improvement in dyspnea. He was also noted to have a left C5 palsy affecting his deltoid function and proximal upper extremity sensation which gradually improved.

Conclusions: This is the first reported case of unilateral diaphragmatic paralysis causing dyspnea due to phrenic nerve palsy following cervical spine surgery. This rare complication should be kept in mind when assessing any patient with respiratory distress following cervical spine surgery.

Background

Cervical myelopathy is a common diagnosis, with a prevalence of approximately 605 in one million people [1]. Treatment entails surgical intervention with anterior cervical discectomy and fusion (ACDF), anterior cervical corpectomy and fusion (ACCF), posterior instrumented fusion with laminectomy, or laminoplasty. A well-known complication of these procedures is C5 nerve palsy, which manifests as deltoid and/or biceps brachii paralysis, and C5 dermatome pain or numbness [2–14]. While nerve palsy extending from C5 to C8 has been reported, pure phrenic nerve palsy is less common [15–17]. Here, we present a case of a patient who underwent posterior spinal instrumentation and fusion (PSIF) with laminectomies for cervical stenosis and subsequently developed phrenic nerve palsy manifesting as dyspnea with hemidiaphragmatic paralysis. To our knowledge, this is the first reported case of a unilateral diaphragmatic paralysis following posterior cervical spine surgery.

Case description

A 69 year-old white male presented to spine clinic with neck pain, gait instability and manual clumsiness. The patient was a former smoker with an extensive past medical history, including morbid obesity

(BMI 42), asthma, sleep apnea, and decreased exercise tolerance. He denied any radicular pain or neurologic changes associated with his neck pain. Physical exam was notable for an antalgic gait and positive bilateral Hoffmann sign, but the remainder of the exam, including pulmonary exam, was unremarkable. He had 5/5 strength throughout the bilateral upper and lower extremities with preserved sensation and 3+ bilateral biceps, knee, and ankle reflexes. Pre-operative imaging was obtained at an outside hospital, and imaging of the chest demonstrated no evidence of phrenic nerve dysfunction prior to surgery (Fig. 1). However, it should be noted that hemiparesis is most identifiable on dynamic fluoroscopy as opposed to a static radiograph. Imaging and presentation was most consistent with severe cervical stenosis with associated myelopathy.

The patient underwent cervical PSIF from C2 to T2 with C3-C7 laminectomies with no immediate complications. Post-operative imaging is shown in Fig. 2. On post-operative day 1, the patient was found to be tachypneic up to the high 20 s with decreased oxygen saturations of 90–92% and increased work of breathing. Pulmonary exam showed labored breathing and decreased breath sounds at the bases without wheezing or crackles. An arterial blood gas revealed respiratory acidosis, and static chest x-ray (CXR) demonstrated low lung volumes and right greater than left bibasilar atelectasis. He was transferred to the ICU for close management of acute hypoxic respiratory failure. His respiratory insufficiency was managed with Bilevel Positive Airway Pressure (BiPAP), and his morphine Patient Controlled Analgesia (PCA) pump was held with transition to oral pain medications. His respiratory status improved, and he was transferred to the floor with co-management by the

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Fig. 1. Pre-operative anterior-posterior (AP) chest x-ray.

Hospitalist and Pulmonary Medicine teams. Per their recommendations, he was also treated with duo-nebulizers, mucolytics, and aggressive pulmonary toilet. His-respiratory insufficiency was thought to be multifactorial due to obesity hypoventilation syndrome, obstructive sleep apnea, recent surgery, atelectasis, poor mobility, poor inspiratory effort due to narcotic medications, and anxiety.

His-initial post-operative exam was notable for sensation intact throughout the left upper extremity with 5/5 strength throughout including deltoid function. On post-operative day four, the patient reported subjective upper extremity weakness and was noted to have developed deltoid weakness with 2/5 strength in the left deltoid as well as decreased sensation in the left neck, upper chest, and proximal arm. His-deltoid weakness later progressed to 1/5 strength on post-operative day nine. This was attributed to a post-operative C5 palsy and was monitored closely.

While on the floor, the patient was transitioned to home Continuous Positive Airway Pressure (CPAP) and weaned down from 10 to 20 L HFNC to 1.5 L oxygen via nasal cannula with appropriate oxygen saturations in the high 90 s. CXR demonstrated improved aeration despite persistent bibasilar atelectasis. Subjectively, the patient reported improvement in his work of breathing and on exam he had clear breath sounds bilaterally without labored breathing. Given his improvement in symptoms, the patient was discharged in stable condition to an acute rehabilitation facility with routine scheduled follow up.

Of note, the patient's respiratory decline resulted in a prolonged length of stay in the hospital up to 14 days. The patient was originally planned for discharge home versus sub-acute rehabilitation, but due to his ongoing medical needs and need for acute physical therapy and occupational therapy he was found to be an appropriate candidate for acute rehabilitation.

Outcome

At his first post-operative clinic visit at three weeks, the patient had persistent left C5 nerve palsy affecting his left deltoid motor function and sensation. Deltoid strength was noted to be 1/5, and he was unable to abduct his arm greater than 5°. His-neurologic exam was otherwise unremarkable, but he continued to have some difficulty breathing with dyspnea on exertion. He was seen as an outpatient by Pulmonary Medicine for his persistent dyspnea, at which point he was found to have unilateral diaphragmatic paresis consistent with phrenic nerve palsy that was not present pre-operatively (Fig. 3). Dynamic fluoroscopy demonstrated diminished right hemi-diaphragmatic excursion. The patient received supplemental oxygen up to 3 L and positive pressure ventilation therapy with BiPAP for respiratory support.

At his six-month post-operative visit, his deltoid strength was noted to be 2/5, and at his one-year post-operative visit he was found to have regained 5/5 deltoid strength although limited shoulder abduction. At his last scheduled follow-up visit two years post-operatively, the patient continued to have some difficulty with his breathing, as well as limited shoulder abduction up to 80°. Although he continued to use his CPAP at night, he no longer required supplemental oxygen and was instructed to continue focused range of motion exercises to improve mobility in the left upper extremity.

Discussion

C5 nerve palsy following cervical surgery occurs in up to 30% of cases, but the true incidence of phrenic nerve palsy following cervical surgery is not known [2-7]. This complication is associated with both

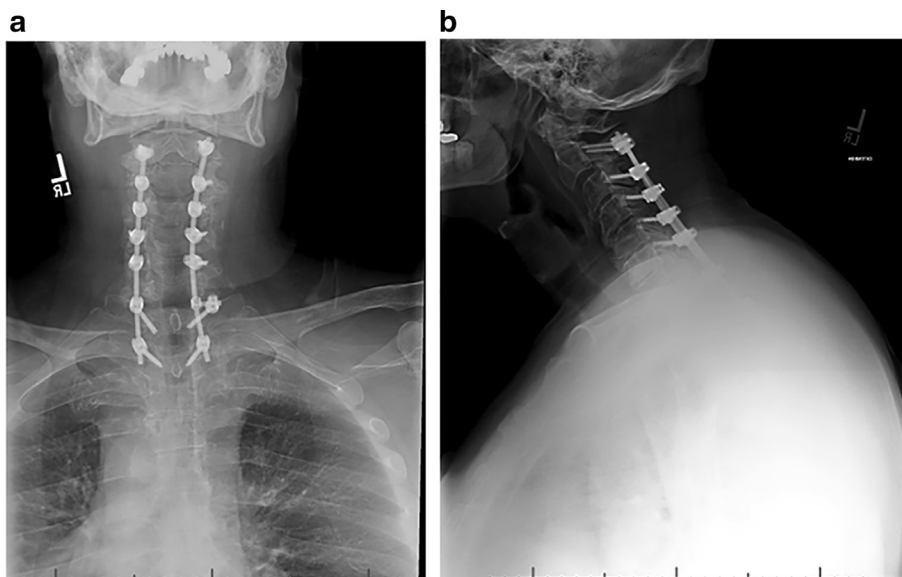


Fig. 2. a,b: Post-operative coronal (a) and sagittal (b) radiographs following C2-T2 PSIF & C3-C7 laminectomies.

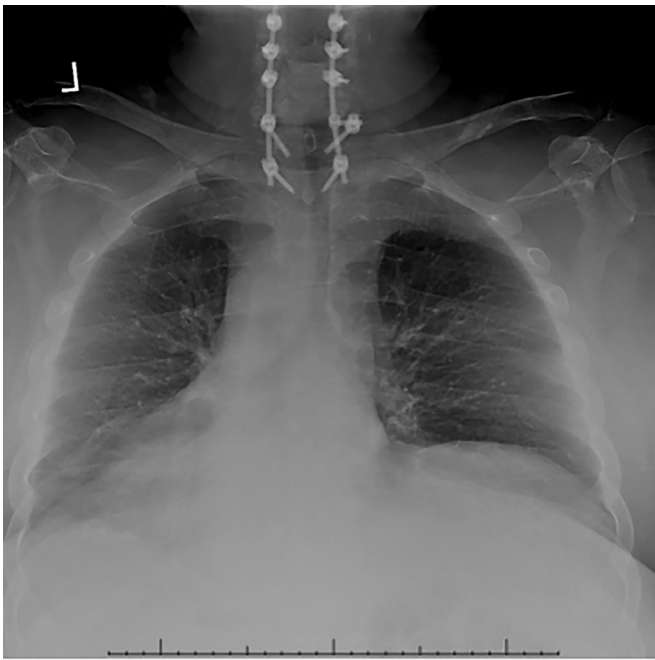


Fig. 3. Post-operative AP chest x-ray demonstrating an elevated right hemidiaphragm.

anterior and posterior approaches, as well as with laminectomies and fusion. Prognosis of the nerve dysfunction ranges from temporary palsy to irreversible injury, though phrenic nerve paresis is generally clinically insignificant [16].

Documented cases of phrenic nerve palsy generally manifest as unilateral diaphragmatic hemiparesis, with one previous report of bilateral phrenic nerve palsy following ACDF [16]. Interestingly, there are reported cases of phrenic nerve palsy resulting from chiropractic manipulation, as well as two cases of phrenic paresis in patients with severe cervical spondylotic myelopathy following cervical manipulation [17–19]. There are also few reported cases of phrenic nerve palsy caused by cervical spondylosis, which was relieved with surgery [20–22]. Pre-existing diaphragmatic hemiparesis should be considered as a possibility in these cases, and the pre-operative spine MRI may reveal an alternative etiology such as neoplastic compression.

The etiology of C5 paralysis and similar nerve palsies in patients undergoing cervical spine procedures remains unclear. Several theories exist, including iatrogenic injury, traction injury, ischemia and reperfusion [3,6,12]. However, as it stands, no definitive etiology for this complication has been established.

While this patient had a prolonged recovery, he ultimately demonstrated improvement in both dyspnea and deltoid function throughout his post-operative course. In the absence of pneumothorax, this rare complication following cervical spine surgery should be kept in mind when evaluating any patient with respiratory distress postoperatively. Post-operative CXR should be examined closely to evaluate for diaphragmatic elevation, and early dynamic fluoroscopy may be a consideration as part of the diagnostic workup for unexplained desaturation and tachypnea. Cervical nerve palsy, although classically involving the C5 nerve, can rarely affect the entire phrenic nerve. A postoperative chest radiograph will demonstrate the classic image of an elevated hemidiaphragm. Management of this complication involves respiratory support with supplemental oxygen and positive pressure therapy as needed in collaboration with the Pulmonary Medicine team.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Patient Informed Consent Statement

The authors declare that informed patient consent was taken from all the patients.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.xnsj.2020.100022.

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