

Ventriculitis and Pneumocephalus Secondary to Tracheoesophageal and Spinal-Esophageal Fistulas in Esophageal Carcinoma: A Rare Neurosurgical Complication

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1. Abstract

1.1. Background: Tracheoesophageal (TEFs) and spinal-esophageal fistulas (SEFs) are rare complications of advanced esophageal carcinoma. While TEFs are relatively well-documented, SEFs remain exceedingly uncommon and present unique neurosurgical challenges, especially when complicated by central nervous system (CNS) infections or pneumocephalus.

1.2. Case Description: We report the case of a 51-year-old man with recurrent esophageal squamous cell carcinoma who developed both TEF and SEF following stent placement. The fistulas resulted in recurrent aspiration, sepsis, ventriculitis, and pneumocephalus. Radiological imaging confirmed a direct communication between the esophagus and the spinal canal, with evidence of osteomyelitis and dural breach. Despite supportive treatment, the patient succumbed to the disease.

1.3. Conclusion: The co-occurrence of TEF and SEF can lead to devastating CNS complications such as ventriculitis and pneumocephalus. Early radiological recognition and multidisciplinary management are essential to mitigate neurosurgical morbidity in such complex cases.

2. Keywords

Esophageal Fistula, Cerebral Ventriculitis, Pneumocephalus

3. Introduction

Esophageal cancer is one of the most common malignancies worldwide, often associated with poor prognoses. The five-year survival rates remain low, varying depending on the stage of the disease. [1]

Esophageal cancer can lead to a range of serious complications during treatment and in advanced stages. One of the most severe complications associated with esophageal carcinoma is the formation of esophageal fistulas, which can involve the respiratory tract, major vessels, or spinal structures [2,3] Tracheoesophageal fistulas (TEFs) are reported in approximately 5-15% of patients with esophageal cancer. On the other hand, spinal-esophageal fistulas (SEFs) are very rare, with only two prior cases documented in the literature. [4-6]

Fistula formation can result in life-threatening infections, especially when esophageal cancer invades nearby structures after radiotherapy. Involvement of the spinal column may result in osteomyelitis, discitis, epidural abscesses, and even intracranial infections via hematogenous or direct extension pathways. [7, 8] The occurrence of ventriculitis and pneumocephalus due to fistula formation is a rare and serious complication, highlighting the neurosurgical importance of this case.

We present a unique case of a patient with esophageal squamous cell carcinoma who developed TEFs and SEFs, leading to ventriculitis and pneumocephalus. This report highlights the neurosurgical implications, pathophysiology, and management of such complications.

4. Case Description

We present the case of a 51-year-old male patient with a history of esophageal squamous cell carcinoma diagnosed eight years ago, initially treated with chemoradiotherapy. Over time, the patient developed dysphagia, which led to the diagnosis of recurrent esophageal cancer. To manage an esophageal stricture, a stent was placed as part of his treatment. Subsequently, the patient developed severe complications, including TEF and SEF. These fistulas resulted in significant difficulties with fluid intake and recurrent pulmonary infections. Thoracic CT revealed a fistula tract between the trachea and the esophagus at the upper segment of the stent, extending to the superior tracheobronchial bifurcation. A PET scan suggested potential invasion of the posterior tracheal wall, showing a loss of the fat layer between the trachea and esophagus in the upper segments.

The patient later developed altered consciousness and high fever. Neurological examination showed classic signs of meningeal irritation, including neck stiffness and positive Kernig's and Brudzinski's signs, prompting a brain MRI for further evaluation. As shown in Figure 1, the MRI findings were consistent with ventriculitis and leptomeningeal involvement, including subependymal edema and contrast enhancement on the ependymal surfaces. A lumbar puncture was performed to confirm the diagnosis of ventriculitis, and broad-spectrum intravenous antibiotics were initiated.

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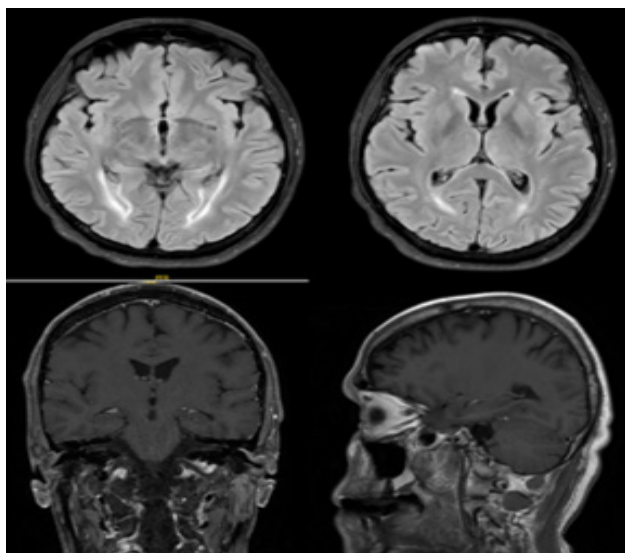


Figure 1: The MRI findings were consistent with ventriculitis and leptomeningeal involvement, including subependymal edema and contrast enhancement on the ependymal surfaces.

Four days later, due to deterioration in the patient's neurological status, as shown in Figure 2, a follow-up brain MRI revealed widespread pneumocephalus. A retrospective review of thoracic CT scans revealed previously unobserved air densities at the left foramen of the T1 vertebra, as well as erosive changes and sclerotic alterations on the anterior surfaces of the T1-T2 vertebrae, as shown in Figure 3.

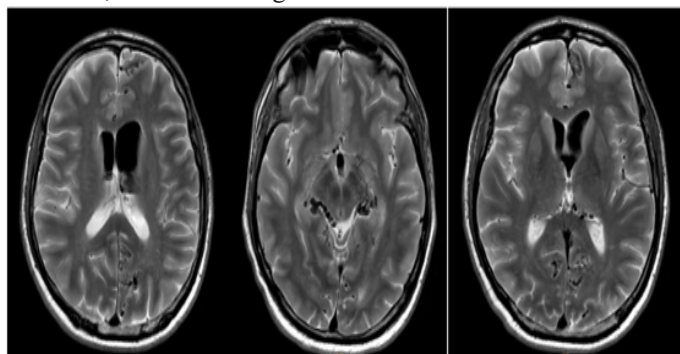


Figure 2: Widespread pneumocephalus observed in the follow-up MRI.



Figure 3: Air densities in the spinal canal and erosive changes on the anterior surfaces of the thoracic vertebrae observed on thoracic CT.

These vertebral changes were suspected to be sequelae of osteomyelitis or osteonecrosis. The possibility of erosion of the thoracic dura and air entering the spinal canal following the development of osteomyelitis or osteonecrosis was also

considered. Following a multidisciplinary evaluation, surgical intervention was deemed inappropriate due to the patient's poor prognosis and intubation risks, and close observing was recommended.

During the observation period, the patient was supported with 100% nasal oxygen and continued intravenous antibiotics. Improvements in the patient's neurological condition were noted, along with a tendency for the pneumocephalus to resolve on control cranial X-rays and CT scans, and a decrease in infection parameters. Consequently, the patient was referred to oncology for the continuation of oncological treatments. Unfortunately, the patient passed away two months later.

5. Discussion

Esophageal cancer, a malignancy with rising global incidence and poor prognosis, often presents at an advanced stage with metastatic spread. A critical anatomical factor contributing to its aggressive nature is the lack of a serosal layer in the esophagus, replaced instead by a loose connective adventitia, which facilitates rapid local invasion and dissemination.[9, 10] Among the rare but severe complications are the formation of TEFs and SEFs, both of which can significantly complicate the neurosurgical management of these patients.[11, 12]

TEFs occur in about 5–15% of esophageal carcinoma cases and lead to significant morbidity from chronic aspiration, cough, and respiratory infections, while SEFs are exceptionally rare and indicate advanced disease, typically caused by neoplastic invasion, radiation-induced ischemia, and secondary infections.[13, 14] The neurosurgical implications of SEF formation are profound, given the potential for vertebral destruction, dural compromise, and subsequent contamination of the cerebrospinal fluid (CSF).

In our case, the coexistence of TEF and SEF led to progressive osteonecrosis and osteomyelitis of the T1–T2 vertebral bodies. Radiological imaging demonstrated intrathecal air and vertebral erosion prior to any neurosurgical intervention, suggesting that dural integrity was breached by a chronic osteomyelitic process. The presence of intraspinal gas before the diagnostic lumbar puncture ruled out an iatrogenic cause, suggesting a direct fistulous connection between the esophagus and the subarachnoid space. These findings emphasize the importance of heightened awareness in patients with known esophageal cancer and developing neurological symptoms.

From a neurosurgical standpoint SEFs present several critical challenges. In our patient, ventriculitis was confirmed via lumbar puncture, which revealed elevated inflammatory markers in the CSF. Although lumbar puncture is a known risk factor for pneumocephalus, retrospective imaging confirmed the presence of spinal air locules beforehand, supporting a spontaneous pathophysiology due to fistulous invasion rather than procedural complication.[15, 16] Similar cases have been reported in literature, where pneumocephalus resulted from malignant invasion of the spinal canal.[17, 18]

The management of SEF-associated complications remains largely supportive and multidisciplinary. While surgical repair may be considered in select patients, the prognosis of advanced-

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stage esophageal carcinoma often limits aggressive neurosurgical intervention. In our case, given the patient's overall condition and limited life expectancy, a palliative strategy focusing on infection control and symptom relief was adopted after comprehensive evaluation by neurosurgery, thoracic surgery, oncology, infectious diseases, and general surgery teams.

Despite the lack of surgical intervention, there are several key neurosurgical considerations that warrant attention in similar cases. Early detection of spinal involvement is critical, especially in esophageal cancer patients who develop back pain, neurologic deficits, or recurrent infections; in such scenarios, spinal imaging should be promptly obtained.[19,20] Diagnostic assessment of CSF contamination through lumbar puncture can provide valuable insights when ventriculitis or meningitis is suspected, but must be interpreted alongside imaging to avoid misattributing complications to procedures. Most importantly, multidisciplinary collaboration remains the foundation of care for these complex patients, ensuring that both surgical and palliative perspectives are considered together in treatment planning.

Overall, SEFs represent a rare but life-threatening complication of esophageal malignancy with significant neurosurgical implications. Neurosurgeons need to be aware of the potential for CNS invasion via fistulous pathways, particularly in patients with advanced thoracic malignancies and vertebral involvement. Early identification, radiologic confirmation, and multidisciplinary management remain the cornerstones of care in mitigating neurologic morbidity in these complex cases.

6. Conclusion

Tracheoesophageal and spinal-esophageal fistulas are rare but severe complications of esophageal cancer, often leading to significant morbidity and neurological decline. This case underscores the critical role of neurosurgeons in diagnosing and managing these complications, particularly when infections like ventriculitis and pneumocephalus occur. Early recognition and a multidisciplinary approach are essential for optimizing patient care. Future advancements in neurosurgical techniques and oncologic therapies may improve outcomes in patients with these complex conditions.

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