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Successful Management of a Foramen Magnum Meningioma that Presented as Recurrent Aspiration Pneumonia and was Associated with COVID-19 Pneumonia with Obstructive Sleep Apnea: A Case Report.

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Abstract:

Foramen magnum meningiomas (FMMs) are rare and challenging tumors. We report a case of foramen magnum meningioma in a 49-year-old female who presented with obstructive sleep apnea and suffered from recurrent aspiration pneumonia. She tested positive for COVID-19. A magnetic resonance image (MRI) revealed a ventral foramen magnum mass lesion that measured 33 mm in diameter, causing a significant pressure effect on the medulla oblongata. After her pneumonia improved, a far lateral retrocondylar approach provided a safe surgical plane for the total excision of this tumor. The pathologic analysis revealed a WHO-grade-I meningioma. Rarely, FMM-compressed medulla oblongata can present with obstructive sleep apnea and recurrent aspiration pneumonia. We successfully removed the entire FMM, resolving her obstructive sleep apnea and recurrent aspiration pneumonia.

Keywords: Foramen magnum, meningioma, Obstructive sleep apnea, Recurrent aspiration pneumonia, COVID-19

Introduction

Foramen magnum meningiomas (FMMs) are rare and challenging tumors. These lesions are skull-based meningiomas, which account for 1.8-3.2% of all meningiomas.[1] Managing FMMs is difficult because they are closely related anatomically to essential structures in a narrow space and critical neurovascular structures such as the brainstem, the lower cranial nerves, and the vertebrobasilar system. FMMs are typically slow-growing with an indolent course, which makes clinical diagnosis complex and often leads to a long interval between the onset of symptoms and diagnosis.[2] FMMs rarely present with respiratory disturbances.[3] They most commonly present with quadriparesis, sensory abnormalities, ataxia, and dysfunction of cranial nerves (CN) IX, X, and XI. Terminal progression includes inability to maintain airway protection with secondary pneumonitis and ultimately respiratory arrest.[2-5] Breathing and swallowing are tightly coupled and are well-controlled by the interaction of neuronal groups co-localized in the medulla oblongata.[6,7] Disruption of breathing-swallowing coordination causes

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aspiration, facilitating repeated pulmonary complications, leading to and including lower respiratory tract infections.[8] Since December 2019, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has become a worldwide pandemic. The SARS-CoV-2 virus causes coronavirus disease (COVID-19), which is an infectious disease that can range from asymptomatic to life-threatening pneumonia. During this pandemic, it was difficult to differentially diagnose pneumonia, which is caused by the aspiration of different materials and SARS-CoV-2.[9]

This report aims to document a rare case of an FMM patient who experienced recurrent aspiration pneumonia, obstructive sleep apnea, and COVID-19 during this visit. We obtained data from outpatient records, surgical reports, inpatient flow charts, and discharge summaries. We obtained the data in January 2022. This report has the patient's informed consent and the ethics committee approval of Phayao Hospital (COA no. 211, PYHREC no. 33/2566).

Case presentation

The patient was a 49-year-old Thai housewife, who presented with fever, productive cough, and shortness of breath one day prior to admission. Eighteen months ago, she was diagnosed with obesity and obstructive sleep apnea (OSA). She has been receiving OSA treatment using continuous positive airway pressure (CPAP) at night, with a pressure range of 8-12 cmH_2O. The individual had a body mass index (BMI) of 33 kg/m^2, with a weight of 85 kg and a height of 159 cm. She experienced occipital headaches and found relief with analgesic medication. In addition, she suffered from repeated episodes of aspiration pneumonia and respiratory failure, which led to her requiring ventilator support on five occasions during hospitalization over the past 18 months. Because of experiencing dysphagia, hoarseness, and a notable weight loss of 6 kg over the past 6 months, the patient underwent a thorough examination including esophagogastroduodenoscopies (EGD), a fiber optic laryngoscope (FOL), and barium swallow evaluations, all of which yielded normal results. Her last admission occurred one month ago; this was due to development of respiratory failure. In addition, she experienced neurological symptoms such as fatigue, ataxia, numbness in all extremities from the neck down, and urinary incontinence. She was nearly bedridden, with a nasogastric tube (NG tube) and a urinary catheter in place until she was discharged, pending a full evaluation of her myelopathy. She was in respiratory distress with a respiratory rate of 40 per minute, oxygen saturation of 89% in room air, a temperature of 38.8°C, a pulse rate of 132 beats per minute, and a blood pressure of 132/74 mmHg. Coarse crepitations were heard bilaterally in the lung fields on inspiration, and the heart sounds were normal. Her mental status was intact; there was no meningeal sign. There was no gag reflex. In all extremities, motor and sensory examinations revealed quadriplegia and hypoesthesia below the posterior neck, as well as hyperreflexia of the deep tendons. Hoffmann's sign was positive on both hands. On both sides, Babinski's signs and ankle clonus were positive.

The chest radiography revealed airspace opacities in bilateral lung fields, more pronounced in the right perihilar regions (Figure 1). The blood gas analysis revealed respiratory failure. The COVID-19 rapid antigen test conducted on a sample taken from the nasopharynx showed a positive result. She had received a booster shot of the Pfizer-BioNTech mRNA vaccine 12 months ago. We assessed her for severe COVID-19 pneumonia. Due to COVID-19, we hospitalized her in the intensive care unit. The patient underwent intubation and received meropenem 1 gm intravenously every 8 hours for 14 days as an empirical treatment for aspiration pneumonia. Additionally, we treated her for COVID-19 by administering molnupiravir 800 mg via a NG tube every 12 hours for 5 days. We also administered intravenous dexamethasone, gradually lowering the dosage over an 11-day period based on the patient's improved symptoms. The initial dosage was dexamethasone 4 mg intravenously every 6 hours for 2 days, followed by every 8 hours for 2 days, then every 12 hours for 2 days, and finally every 24 hours for 5 days. She had a favorable response to the treatment. On the ninth day following admission, we were able to remove the mechanical respirator and endotracheal tube. The clinical and chest radiography had shown improvement (Figure 2). The bacterial cultures, such as hemoculture, sputum culture, and urine culture revealed no evidence of bacterial proliferation.

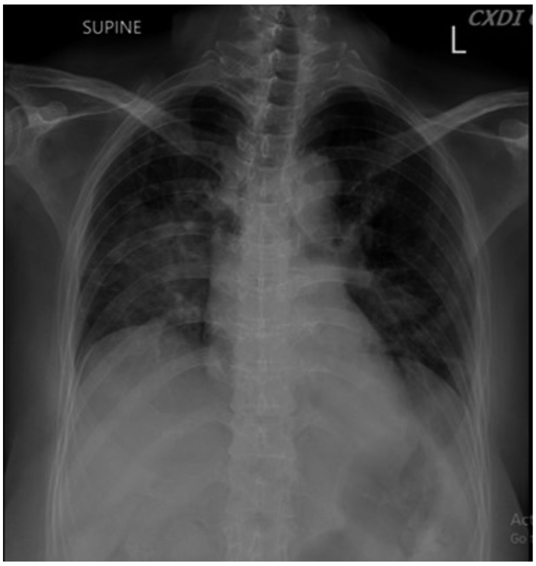

Figure 1 The chest radiography revealed air space opacities in bilateral lung fields, more pronounced in the right perihilar regions.

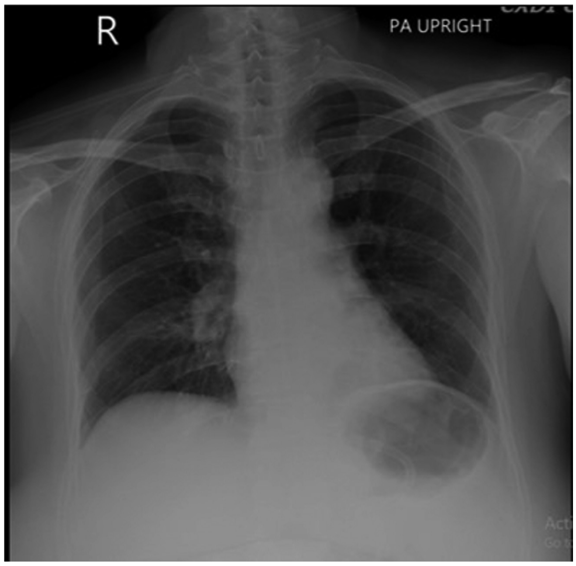

Figure 2 The chest radiography revealed improved lung fields, a response to treatment and resolved pneumonia.

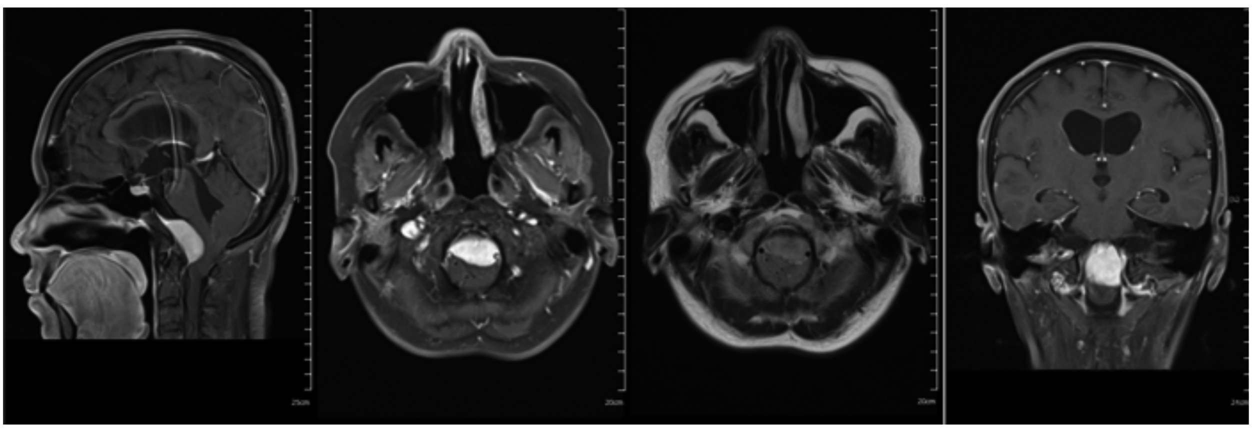

Figure 3 Magnetic resonance imaging (MRI) scan revealing a mass with a board dura base. This was a homogenously enhancing mass, measuring about 2.2 x 3.3 x 3.3 cm in the prepontine cistern, pre-medulla oblongata, posterior aspect of the clivus,and craniocervical junction, encasing the left vertebral artery, with a mass effect to cause canal stenosis. Foramen magnum meningioma is the is the most likely diagnosis.

After the patient stabilized, we ordered a magnetic resonance imaging (MRI) scan of the brain and cervical spine based on the patient's neurologic findings and suggestions of myelopathy. There revealed a board dura base homogenously enhancing mass, measuring about 2.2 x 3.3 x 3.3 cm in the prepontine cistern, pre-medulla oblongata, posterior aspect of the clivus, and craniocervical junction, with a mass effect enough to cause canal stenosis (Figure 3). Neurosurgical resection was performed after the pneumonia had resolved, and rapid antigen testing of a nasopharyngeal swab was negative for COVID-19 in the third week after admission. The neurosurgeon utilized the far lateral retrocondylar approach on the patient's left side. The neurosurgeon positioned the patient in a three-quarter position and made a hockey stick-shaped incision on the skin, starting from the mastoid process and extending upwards along the superior nuchal line. From there, the incision followed a curved path towards the inion, then downwards to the cervical spinal process. After dissection of the suboccipital muscles, elevation of the atlas (C1) hemilamina periosteum toward the sulcus vertebralis was performed, being careful not to damage either the periosteum or the vertebral artery (VA) 's venous plexus. This maneuver entails elevating and mobilizing the horizontal VA segment, which facilitates hemilaminectomy and lateral drilling. The surgeon elevated a posterolateral retrocondylar suboccipital craniotomy, encompassing the rim of the FM. The retrocondylar approach, which does not involve condylar drilling, provides a beneficial visualization while also helping to preserve joint stability. The surgeon microsurgically opened the dura just behind the VA's dural entry. The spinal portion of the accessory nerve was identified and preserved and was located posterior to the tumor. In cases of anterolateral tumors, partial removal of meningiomas revealed the intradural segment of the VA and its branches. To achieve internal debulking, patients with firm consistency tumors underwent piecemeal resection with microscissors and cupped forceps. The far lateral retrocondylar approach provides a secure surgical plane for complete removal of these tumors (Figure 4). The surgical specimen's pathological evaluation confirmed Grade I meningothelial meningioma, according to the World Health Organization (WHO). She was extubated from the mechanical ventilator on the second day after surgery. Seven days after the surgery, her neurological exam returned to normal, showing only mild residual numbness over both toes, a still reduced left gag reflex, and a new slight leftward deviation on her tongue protrusion. The patient experienced symptomatic recovery, beginning with immediate resolution of paresthesia, and was able to walk with reasonably normal gait in the second week after surgery. The patient's hoarseness and dysphagia improved, and she was able to remove the NG tube in the 6th week after the surgery. By the 8th week, the tongue deviation had disappeared and the gag reflex was fully recovered. By three months she was able to walk independently and without gait abnormality. We ordered a further MRI scan of the brain and cervical spine for follow-up postoperatively. The prepontine cistern, premedulla oblongata, and posterior of the clivus revealed post-tumor removal without any abnormal enhancing lesions (Figure 5). After six months of surgery, OSA symptoms disappeared without the need to use CPAP.

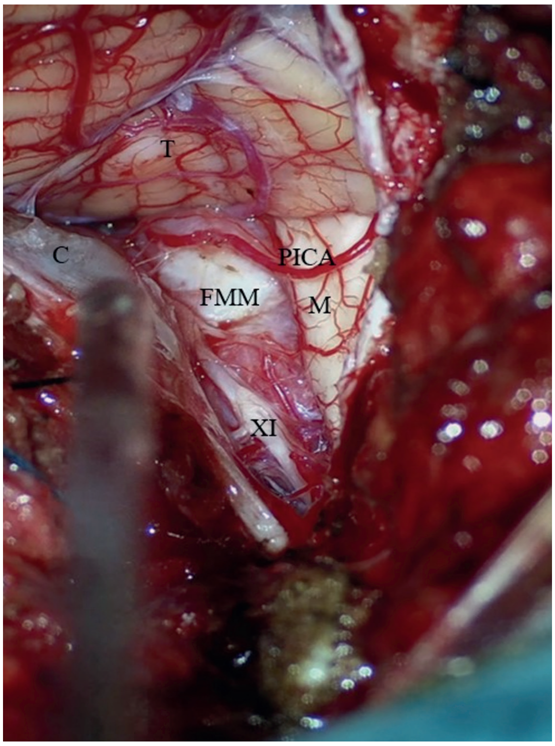

Figure 4A The left-sided far lateral retrocondylar approach: The horizontal VA segment was mobilized by elevating and not damaging the C1 hemilanima periosteum for hemilaminectomy and lateral drilling. The dura was microsurgically opened, and the spinal portion of the accessory nerve was preserved, located posterior to the tumor.

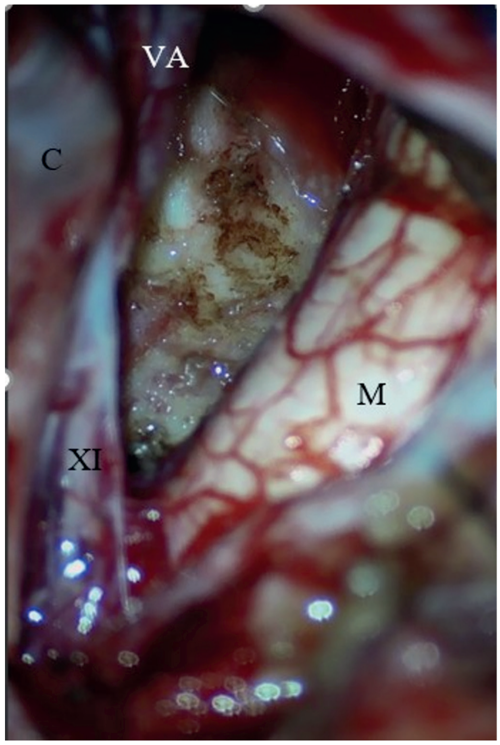

Figure 4B The left-sided far lateral retrocondylar approach: Partial removal of meningiomas revealed the intradural VA segment and its branches, providing a safe surgical plane for the total excision of foramen magnum meningioma.

FMM: Foramen magnum meningioma,
M: medullar oblongata, C: Occipital condyle,
T: Tonsillar of cerebellum, PICA: Posteroinferior cerebellar artery, XI: Cranial nerve XI

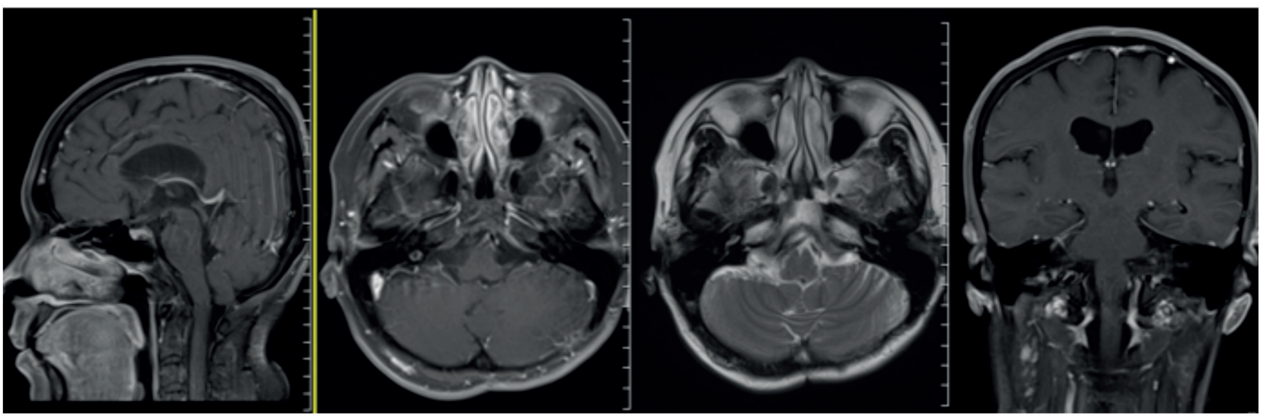

Figure 5 Magnetic resonance imaging (MRI) scan revealing post-tumor removal without abnormal enhancing lesions at the prepontine cistern, premedulla oblongata, and posterior of the clivus.

Discussion

Meningiomas, the most common brain tumor, account for 25-40% of intracranial primary tumors, primarily affecting females. Their incidence increases with age, and they are more prevalent in African-Americans.[1-3,10,11] Rarely occurring, FMMs are a common histological tumor in a challenging anatomical region due to their proximity to critical structural locations. FMMs originate from the arachnoid cells at the craniocervical junction's dura mater, a region from the lower third of the clivus to the upper margin of the axis (C2) body.[2,12] Performing surgery in this location is difficult because there are numerous delicate neurovascular structures that are susceptible to injury. The neural structures include the cerebellar tonsils, the inferior vermis, the fourth ventricle, the lower CN (IX-XII), the rostral section of the spinal cord, and the upper cervical nerves (C1 and C2). The anterior and posterior spinal arteries, posterior inferior cerebellar arteries (PICAs), and VA are among the crucial vessels.[2,13] The surgical procedure in this case is highly complex due to the presence of a ventrolateral type FMM, which is hidden in a narrow space in front of the medulla. This FMM exerts pressure on the CN VII-X, causing them to move upward while also pushing the CN XI backwards. Furthermore, it compresses the CN XII and partially encased the VA where it entered the dura. FMMs, whose clinical presentation varies depending on the size and localization of the tumor, can mimic many other neurological disorders. The clinical course is indolence with nonspecific symptoms, slowly progressing until the tumor is large enough to cause a mass effect. Long tract involvement, asymmetric motor weakness, gait ataxia, and a relatively uncommon lower CN palsy frequently manifested.[3,14,15] In this report, a 49-year-old obese female presented with rare clinical symptoms of FMM.[2] She suffered from sleep apnea with recurrent aspiration pneumonia and had progressed to quadriplegia, ataxia, and bedridden status. There are many reports of an association between the medulla oblongata lesion and sleep apnea. Smith et al. identified a specific area in the ventral medulla called the pre-Bötzinger complex, which is a component of the central pattern generator (CPG) responsible for regulating breathing. The neuron networks in this region autonomously generate rhythmic motor patterns such as walking, breathing, swallowing, and coughing without relying on signals from the motor cortex. The CPG is responsible for generating the regular rhythm and pattern of breathing by utilizing the inherent features of neuronal membranes and their interconnections. Tonic excitation is essential for expression, sourced from wakefulness dependent neural systems and peripheral and central chemoreceptors. The retrotrapezoid nucleus, located near the ventral surface of the medulla, contains central chemoreceptors that are intrinsically sensitive to changes in CO2/H+ levels. These neurons have dendrites that extend to the ventral medullary surface; they sense the pH of the surrounding cerebrospinal fluid (CSF), and axons that project to the pre-Bötzinger complex.Tonic excitation removal can disrupt respiratory rhythm, resulting in central sleep apnea. Compression of the nucleus ambiguus, which regulates pharyngeal tone, can exert pressure on CN IX and X, resulting in occlusive apnea.[16-23] The FMMs compress the ventrolateral part of the medulla oblongata, which may compress the pre-Bötzinger complex, retrotrapezoid nucleus, nucleus ambiguus, and present with obstructive sleep apnea (Figure 6).

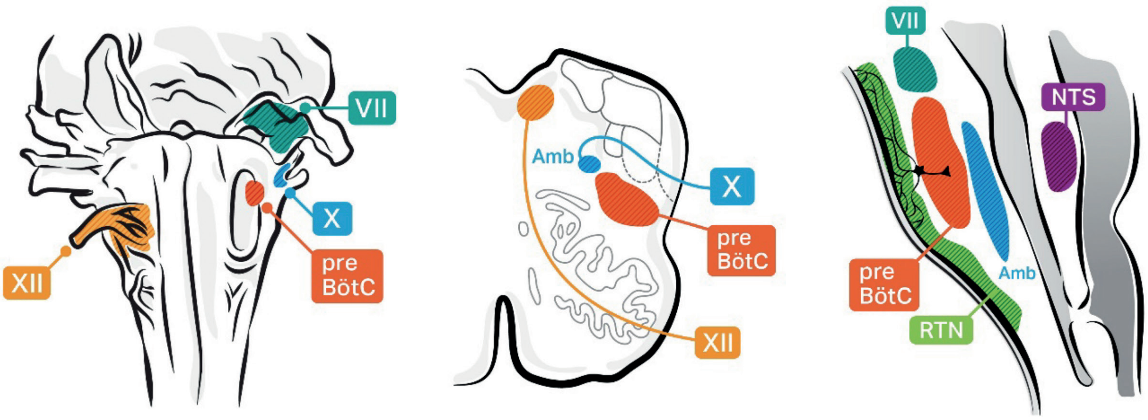

Figure 6 The central pattern generator (CPG) is located ventrolaterally in the medulla oblongata. Pre-Bötzinger complex (pre-BötC) is located in the ventrolateral medulla, caudal to the facial nucleus (VII) and ventral to the compact part of the nucleus ambiguus (Amb), a component of ventral breathing CPG, generating the regular rhythm and pattern of breathing. The retrotrapezoid nucleus (RTN), which is near the ventral surface of the medulla, is a central chemoreceptor that responds to changes in the amount of CO2/H+ in the CSF and connects to the pre-BötC. Nucleus tractus solitarius (NTS) is a component of dorsal breathing CPG. It is also the projection site for afferents critical to breathing reflex control: the carotid and aortic chemoreceptors and baroreceptors, as well as lung vagal afferents. The nucleus ambiguus send signals to the larynx and pharynx muscles through the vagus, glossopharyngeal, and accessor nerves. Hypoglossal (XII) that innervate muscles important to the maintenance of upper airway patency.

OSA is an inflammatory disorder characterized by elevated tumor necrotic factor alpha (TNF-α) levels, and intermittent hypoxia induces macrophage polarization and increased interleukin 6 (IL-6) production, confirming the presence of classic inflammatory cytokines. This increases an individual's risk of developing cardiovascular disease, endocrinologic abnormalities, and even early mortality.[24,25] We performed total tumor excision and medulla oblongata decompression in this case. Clinical OSA is reversible and can be weaned off CPAP within 6 months postoperatively. This case is analogous to previously reported cases of reversible obstructive sleep apnea after surgery to decompress the lower brain stem.[19,26]

Inhaling oropharyngeal secretions or gastric contents into the larynx and lower respiratory tract, colonized by pathogenic bacteria, causes aspiration pneumonia, an infection of the pulmonary parenchyma. Airway protective behaviors, such as swallowing and coughing, are frequently impaired in neurologic disease and contribute to an increased risk of aspiration.[27] A CPG located in the nucleus tractus solitarius (NTS) and the nucleus ambiguus in the medulla oblongata produces swallowing movements. The CPG integrates sensory signals from the mouth and sends them further down to the cranial motoneurons (CN V, IX, X, and XII), which then close the larynx and perform peristalsis in the pharynx and esophagus.[28,29] Cough is a defensive reflex that prevents aspiration by producing a rapidly rising expiratory airflow to eject adherent material away from the vocal folds. The brainstem's NTS also houses the cough pattern generator. This case suffers from recurrent aspiration pneumonia, which indicates an underlying pathology in the functioning of speaking, swallowing, breathing, or maintaining airway protection.[30] The uncommon presentation of FMM demonstrates that a compressed and displaced medulla oblongata can disrupt airway protection, leading to a missed diagnosis, which is the definitive cause of recurrent aspiration pneumonia. This case also follows the same course as a previous study that showed that pathology in the medulla oblongata can cause problems in airway protection, dysphagia and aspiration pneumonia.[31-35]

The COVID-19 pandemic spread across the world; this case was admitted for COVID-19 pneumonia and recurrent aspiration pneumonia. Definite discrimination in diagnosing pneumonia caused by aspiration of different materials or SARS-CoV-2 might be impossible.[36,37] While there isn't universal agreement on the gold standard for diagnosing aspiration pneumonia, a broad consensus suggests considering pneumonia in the context of suspected aspiration or dysphagia. Clinical criteria include acute respiratory symptoms, fever, and newly infiltrated areas in a typical location. In supine positions, the posterior segments of the right upper lobe and the right apical segment of the lower lobe are most likely affected. The patient is at risk for oral colonization of bacteria on the NG tube due to dysphagia, poor oral hygiene, malnutrition, and antibiotic use. She also faces the risk of aspiration due to OSA.[30] Early administration of antibiotics in presumed cases of aspiration pneumonia is required to prevent morbidity and mortality[38], and the correct triage of these patients is essential to decrease the risk of the spread of infection and to protect medical personnel from inadvertent exposure to the infection. Radiologic features such as bilateral subpleural patches of ground glass opacity (GGO), especially in basal distribution, as typical for the diagnosis of COVID-19 pneumonia in suspected cases, are also fairly common in aspiration pneumonia.[36] For diagnosis COVID-19, the rapid SARS-CoV-2 antigen showed comparable sensitivity and specificity with the real-time reverse transcription polymerase chain reaction (RT-PCR) assay.[39] This case is analogous to previously reported COVID-19 and aspiration pneumonia, which challenges the differential diagnosis of pneumonia.[36,40] In this case, it may be possible that both conditions were co-existing.

There have been previous reports of FMM with COVID-19 in pregnant women who lost their lives as a result of the additional complications, one patient had to undergo urgent surgery due to rapid clinical deterioration.[41] In this case report, the far lateral retrocondylar approach to FMM resection with COVID-19 yielded a favorable outcome. After her pneumonia resolved she underwent surgery. In this case, she had already had a Pfizer-BioNTech mRNA vaccine. Similar previous studies indicate that vaccines appear to be safe and effective tools in preventing severe COVID-19, hospitalization, and death against all variants of concern.[42]

Conclusion

Successfully completely removing FMM resolved the obstructive sleep apnea and aspiration pneumonia in a COVID-19 patient. Rarely, FMM-compressed medullar oblongata can present with sleep apnea and aspiration. The OSA and recurrent aspiration pneumonia may indicate an underlying pathology in the medulla oblongata.

Conflict of interest

The author has declared no conflict of interest.

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