

to 82%. She was also administered IV hydrocortisone, 250 mg once. However, she began desaturating on 15 L of oxygen and hence started on non-invasive positive pressure ventilation (NIPPV). The patient was unable to tolerate NIPPV for long as she reported feeling suffocated each time she was on it.

The patient was transferred to the Medical intensive care unit (ICU) on the same day with a diagnosis of chemical pneumonitis. A repeat chest X-ray showed a minor consolidation adjacent to the left heart border. Right lung appeared clear (Figure 2). IV methylprednisolone was started at 40 mg q6h and was tapered to q8h the next day. The patient refused a trial of NIPPV.

The next day, the patient's oxygen saturation was 97%–100% on 2 L oxygen. Her respiratory rate was 30–34 breaths per minute with suprasternal retractions.

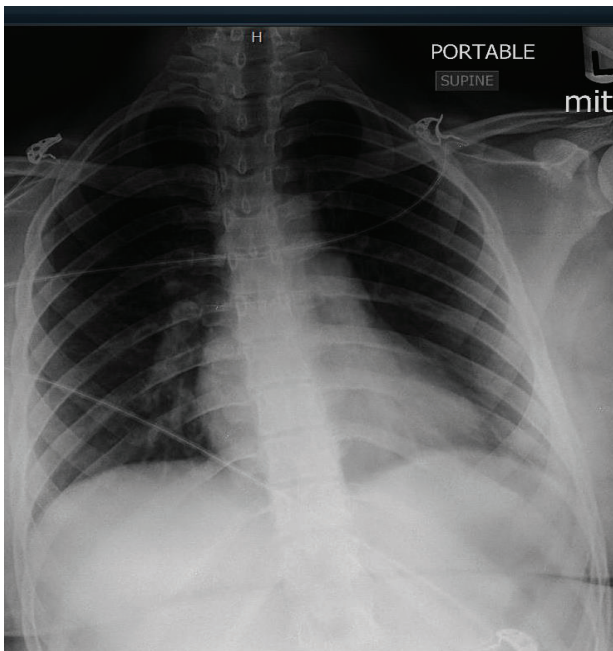


Figure 1. Opacified bronchi in the right lower lung with radiographic pattern of para hilar peribronchial prominence.

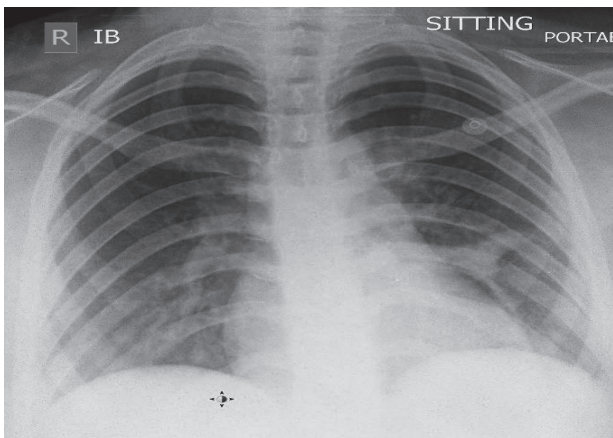


Figure 2. Minor consolidation adjacent to the left heart border. Right lung appears clear.

On auscultation, bilateral rhonchi with decreased air entry were present on both sides. Laboratory findings revealed marked elevation of the white blood cell (WBC) count, from $10.67 \times 10^9/l$ at admission to $27.67 \times 10^9/l$; with a neutrophilic count of $26.28 \times 10^9/l$ following which, superimposed bacterial pneumonia was suspected and the patient was started on IV Piperacillin-Tazobactam 4g, q8h. Chest X-ray repeated showed no new finding (Figure 3). The patient remained afebrile.

On day 3, the patient got improved, with the respiratory rate in 20s and no suprasternal retractions. Auscultation revealed basal rhonchi and laboratory findings showed a decrease in WBC count to $21.80 \times 10^9/l$. The oxygen nasal cannula was removed but she desaturated to 92% and hence kept on 2 L of oxygen via nasal cannula. Methylprednisolone was tapered to 40 mg BID and Piperacillin-Tazobactam was to be continued for 5 days.

On day 4, the patient improved clinically and required intermittent oxygen flow of 1 L/minute via nasal cannula as the oxygen saturation still dropped to 88% on activity. However, she was able to maintain the oxygen saturation at 93% on room air. The patient was shifted from the medical ICU to the general ward.

On day 6, her lungs were clear to auscultation and she was able to maintain an oxygen saturation of greater than 95% on room air for 24 hours. In light of the findings, the patient was discharged the same day with the following medications:

- Albuterol 2.5 mg, 1.25 ml, NEB, q6hr, PRN: Asthma symptoms.
- Budesonide: 0.5 mg, 1 ml, NEB, q12hr.
- Methylprednisolone: 20 mg, PO
- Pantoprazole: 40 mg, PO for 5 days

The patient was given an appointment to follow-up in the outpatient clinic after 1 week but the patient did not return. On the basis of a telephonic conversation, it was found that the patient is following up in private pulmonology clinic. She has been asymptomatic for 4 months

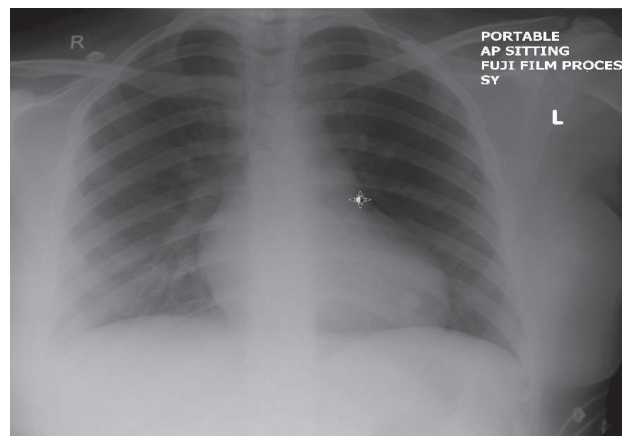


Figure 3. Normal cardio mediastinal contours with clear lungs.

since her acute illness and is planning to follow-up with the same doctor for a total of 6 months.

Discussion

Lycopodium powder consists of dried spores of club moss plants, principally *Lycopodium clavatum*. These spores are flammable when they come in contact with air due to their high oil content [4]. Lycopodium powder has been used in explosives and fireworks, in magic acts to create the fire breath, and in physics and chemistry laboratories of schools for experiments in accordance to its hydrophobic and flammable properties [2]. Our case happened during a high school chemistry experiment class.

However, there is evidence for the presence of medical advantages of Lycopodiaceae. Certain species of Lycopodiaceae were shown to have anti-inflammatory properties [5]. *Huperzia Serrata*, a species from the Lycopodium family produces a bioactive alkaloid called Huperzine A, is a potent inhibitor of acetylcholinesterase and is used for the treatment of Alzheimer's disease [6,7]. A homeopathic study on animals done in 2014 revealed that *L. clavatum* 30C had hepatoprotective effects in paracetamol-induced liver damage, characterized by reduced necrosis and inflammation of the liver tissue [8]. A 2010 study showed the plausible presence of anticancer properties of *L. clavatum* [9]. However, not many studies have been conducted to explain the toxicities of lycopodium.

Pulmonary aspiration syndromes encompass a group of diseases caused by inhalation or aspiration of foreign material into the lung. The type of syndrome is dependent on the amount and nature of the aspirated substance, duration of exposure, as well as the host responses [10,11]. These syndromes can be categorized into airway disorders, such as obstruction of large airways with a foreign body and bronchiectasis, or parenchymal disorders, such as aspiration pneumonitis and pneumonia [11]. A form of chemical pneumonitis caused by inhalation of liquid hydrocarbons such as lamp oils used for fire breathing, also called fire breather's pneumonia or hydrocarbon pneumonitis, has a similar presentation comparable to lycopodium inhalation and usually does not show specific clinical signs but 1%–2% might be fatal with cyanosis, apnea, or cardiac arrest [12].

A case similar to ours was presented in 2008, where a 23-year-old gentleman had accidentally inhaled lycopodium spores while fire breathing. The patient was initially being treated as a case of tuberculosis as his lung biopsy showed granulomatous changes. However, it was only after careful interrogation that it was revealed that the patient had aspirated lycopodium spores and this shows that a thorough history is vital in cases where presentations can overlap [13]. *L. clavatum* spores were used in dusting powders of many hospitals in the 20th century.

Another case reported in 2015 was a 16-year-old female who accidentally inhaled hydrocarbon and developed hydrocarbon pneumonitis, commonly known as fire-eater's pneumonia. Although, the exact cause of her condition was not due to lycopodium. Both hydrocarbons, as well as lycopodium, are used by magicians in their fire-breathing trick and may have fatal consequences. Even though the patient recovered, there are no guidelines to treatment or management of these patients which means prognosis of every patient can differ [14].

There have been cases of lycopodium granulomas years after the spores enter the body. One such case was reported in 1988 where a patient was diagnosed with lycopodium granuloma nearly 50 years after an appendectomy. When lycopodium spores gain access into the body through a surgical wound, they can form a granulomatous lesion months or even years later. This implies the importance of adequate follow-up of patients having had a close encounter with lycopodium spores [15]. Two cases of asthma have also been reported following occupational lycopodium exposure, especially in firms making contraceptive sheaths for men [2].

In regards to the management of lycopodium aspiration pneumonitis, there is no standard therapy available, but most of the reported cases have tried IV steroid which may have caused an increase in the neutrophilic WBC count observed on day 2 in this patient.

Conclusion

There is minimal literature pertaining to the development of chemical pneumonitis due to aspiration of lycopodium despite the presence of medical advantages of Lycopodiaceae. The various risks of using lycopodium have yet to be clearly established. Hence, it was important to report this case and to focus on the implementation of safety precautions while using lycopodium powder not only in school setting but all other work environments that make use of such products. In this case, on a telephonic follow-up with the mother of the patient, it was found that this was the first time an accident of this nature took place in the school and therefore, the school decided to replace lycopodium powder with milk powder and enforce the use of mask as a mandatory requirement. We are happy that after 4 months, the patient is doing well and does not have any respiratory symptoms.

Acknowledgments

We would like to express our sincere gratitude to Dr. Husain A Alawadhi, Chief of Medical ICU, Mafraq Hospital, Abu Dhabi, for providing us with support and guidance to present this case report.

List of Abbreviations

ICU	Intensive care unit
NIPPV	Non-invasive positive pressure ventilation

Consent for publication

Informed consent was obtained from the patient.

Ethical approval

Ethical approval is not required at our institute to publish an anonymous case report.

Author details

Mahroo Khalid¹, Avantika Lakshmi Narasimhan¹, Maryam Kaizar Master¹

1. Gulf Medical University, Ajman, United Arab Emirates

References

- Hussain G, Rasul A, Anwar H, Aziz N, Razzaq A, Wei W, et al. Role of plant derived alkaloids and their mechanism in neurodegenerative disorders. *Int J Biol Sci.* 2018;14(3):341–57. <https://doi.org/10.7150/ijbs.23247>
- Cullinan P, Cannon J, Sheril D, Taylor AN. Asthma following occupational exposure to *Lycopodium clavatum* in condom manufacturers. *Thorax.* 1993;48:774–775. <https://doi.org/10.1136/thx.48.7.774>
- Mao XY, Cao DF, Li X, Yin JY, Wang ZB, Zhang Y, et al. Huperzine A ameliorates cognitive deficits in streptozotocin-induced diabetic rats. *Int J Mol Sci.* 2014;15(5):7667–83. <https://doi.org/10.3390/ijms15057667>
- Živcová Z, Gregorová E, Pabst W. Porous alumina ceramics produced with lycopodium spores as pore-forming agents. *J Mater Sci.* 2007;42:8760–4. <https://doi.org/10.1007/s10853-007-1852-y>
- Banerjee J, Biswas S, Madhu NR, Karmakar SR, Biswas SJ. A better understanding of pharmacological activities and uses of phytochemicals of *Lycopodium clavatum*: a review. *J Pharmacogn Phytochem.* 2014;3(1):207–10.
- Sahidan NS, Choo CY, Latiff S, Jaman R. Variations of huperzine A content in Lycopodiaceae species from tropics. *Chinese J Nat Med.* 2012;(10):125–8.
- Damar U, Gersner R, Johnstone JT, Schachter S, Rotenberg A. Huperzine A: a promising anticonvulsant, disease modifying, and memory enhancing treatment option in Alzheimer's disease. *Med Hypotheses* 2017;(99):57–62.
- Henrique SG, Barros PP, Silva GGM, Landi MA. Hepatoprotective effect of *Lycopodium clavatum* 30CH on experimental model of paracetamol-induced liver damage in rats. *Homeopathy.* 2015;104(1):29–35.
- Mandal SK, Biswas R, Bhattacharyya SS, Paul S, Dutta S, Pathak S, et al. Lycopodium from *Lycopodium clavatum* extract inhibits proliferation of HeLa cells through induction of apoptosis via caspase-3 activation. *Eur J Pharmacol.* 2010;626(2–3):115–22. <https://doi.org/10.1016/j.ejphar.2009.09.033>
- Marik PE. Pulmonary aspiration syndromes. *Curr Opin Pulm Med.* 2011;17(3):148–54. <https://doi.org/10.1097/MCP.0b013e32834397d6>
- Hu X, Lee J, Pianosi P, Ryu J. Aspiration-related pulmonary syndromes. *Recent Adv Chest Med.* 2015;147(3):815–23. <https://doi.org/10.1378/chest.14-1049>
- Kadalkal F, Uysal MA, Gülhan NB, Turan NG, Bayramoğlu S, Yilmaz V. Fire-eater's pneumonia characterized by pneumatocele formation and spontaneous resolution. *Diagn Interv Radiol* 2010;16:201–3.
- Morresi-Hauf A, Neher A, Wöckel W, Kammler-Baumann H. Granulomatous bronchiolitis due to aspiration of lycopodium spores by fire-breathing. *Pneumologie.* 2009;63(2):67–71. <https://doi.org/10.1055/s-2008-1038256>
- Olchoway C, Lasecki M, Inglot M, Zaleska-Dorobisz U. Case report of fire eater's Pneumonia in adolescent female patient—evolution of radiologic findings. *Pol J Radiol.* 2015;80:18–21. <https://doi.org/10.12659/PJR.892227>
- Nadjem MA, Graham JH, Johnson FB. *Lycopodium granulosum*. *J Cutaneous Pathol.* 1988;15(2):120–3. <https://doi.org/10.1111/j.1600-0560.1988.tb00531.x>

Summary of the case

Patient (gender, age)	1	Female, 15 year old
Final diagnosis	2	Chemical pneumonitis
Symptoms	3	Rapidly progressing dyspnea associated with multiple episodes of non-productive cough, chest tightness, and nausea
Medications	4	15 L of oxygen, hydrocortisone, methylprednisolone, and Piperacillin-Tazobactam
Clinical procedure	5	15 L of oxygen through a non-rebreather mask and single dose of IV hydrocortisone 20 mg was administered on admission. On transfer to the ICU, IV methylprednisolone 40 mg q6h started and tapered to q8h on day 2 and BID on day 3. IV Piperacillin-Tazobactam 4 g q8h was started on day 2 as superimposed bacterial infection was suspected and continued for 5 days.
Specialty	6	Medical Intensive Care Unit (ICU)