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CASE REPORT

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Primary pulmonary meningioma: a case report and literature review

Jun Cheng[1] and Chunfen Guo[2*]

Abstract

Introduction Primary pulmonary meningioma is a rare disease. There have been only a little over 50 cases of primary pulmonary meningioma (PPM) reported in previous literature. The pathogenesis of PPM is still unclear. We report a case of PPM cured by thoracoscopic right middle lobe wedge resection and systematically review previously reported cases in previous literature.

Case report A 57-year-old male patient was found to have a nodule in the right middle lobe of about 1.8 cm in diameter on a chest-enhanced CT scan performed more than 7 years ago. A re-examination in 2023 found the subpleural nodule in the right middle lobe had grown larger than before. Considering surgical treatment, the patient underwent a thoracoscopic right middle lobe wedge resection after a thorough examination. The final pathological diagnosis was primary pulmonary meningioma. Regular follow-up CT scans showed no recurrence.

Conclusion Primary pulmonary meningioma is a rare tumor that occurs in sites similar to lung cancer. Most cases are solitary, presenting as ground-glass nodules (GGO), and can occur in multiple lobes, involving the mediastinum and pleura with multiple nodules. Clinical and radiological diagnoses are often challenging, especially distinguishing from primary lung cancer. Surgery remains the optimal choice for the diagnosis and treatment of PPM. Most cases are benign with a good prognosis, and wedge resection is usually the preferred surgical approach. A small proportion of malignant cases may require lobectomy and adjuvant radiotherapy and chemotherapy due to tumor invasiveness.

Keywords Primary pulmonary meningioma, Meningioma, Ectopic primary meningiomas, Case report

Background

Meningiomas are common primary tumors of the central nervous system (CNS), whereas ectopic primary meningiomas are relatively rare, mainly located in the head and neck area [1]. Primary pulmonary meningioma (PPM) is considered a rare disease [2]. Xiangtan Central Hospital treated a patient with primary pulmonary meningioma in 2023, who was cured by thoracoscopic right middle lobe wedge resection. We have collected and analyzed literature reports of primary pulmonary meningioma cases from 1982 to 2024, totaling 52 articles. After excluding duplicate reports and cases, we identified 55 reported cases. Adding our case, the total comes to 56 cases. We analyzed and summarized information from these case reports, including the date of report, patient's geographical location, gender, age, and tumor location, to enhance clinicians' understanding of this disease.

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Case report

A 57-year-old asymptomatic male was admitted to our hospital due to a lung nodule that had been present for over seven years. The patient underwent a chest-enhanced CT scan at our hospital 7 years ago, which showed multiple small nodular shadows in both lungs,

with a nodule in the right middle lobe about 1.8 cm in diameter. At the time, this finding was not given due attention, that is, no further treatment such as puncture biopsy was undertaken, and no regular follow-up was scheduled. In November 2023, due to stomach discomfort, a repeat chest CT scan at another hospital revealed an enlarged mass in the right middle lobe, leading the patient to our hospital for further investigation. The CT scan showed that the subpleural nodule in the right middle lobe had grown larger than before, about 3.2cm in diameter (see Fig. 1). Laboratory tests: Tumor markers (NSE + cytokeratin-19 fragments + pro-gastrin-releasing peptide + squamous cell carcinoma-related antigen (SCC) + carcinoembryonic antigen + CA12-5) results were all negative. PPD skin test: (+++). Acid-fast staining (sputum): Automatic acid-fast staining Negative. Head CT, enhanced brain MRI, and whole-body bone scan showed no significant abnormalities.

The patient and his family consented to a CT-guided percutaneous needle biopsy for further investigation, which, however, resulted in mild hemoptysis (approximately 2 ml in total) that was managed conservatively with hemostatic agents and supportive care. Histological examination of the biopsy specimen using a rapid paraffin section technique revealed spindle cell proliferation with the presence of occasional multinucleated giant cells; notably, no significant coagulative necrosis was observed. While these findings pointed towards a spindle cell neoplasm, the possibility of tuberculosis could not be definitively ruled out, prompting an immunofluorescence assay for Mycobacterium tuberculosis, the results of which returned negative. Given the considerable enlargement of the right middle lobe nodule and the inconclusive results of the initial biopsy, a multi-disciplinary team (MDT) convened to discuss the case and recommended surgical resection for definitive diagnosis and treatment. Following the MDT recommendation, the patient subsequently underwent thoracoscopic surgery. Intraoperative findings revealed extensive pleural adhesions, encompassing the right lung, chest wall, pericardium,

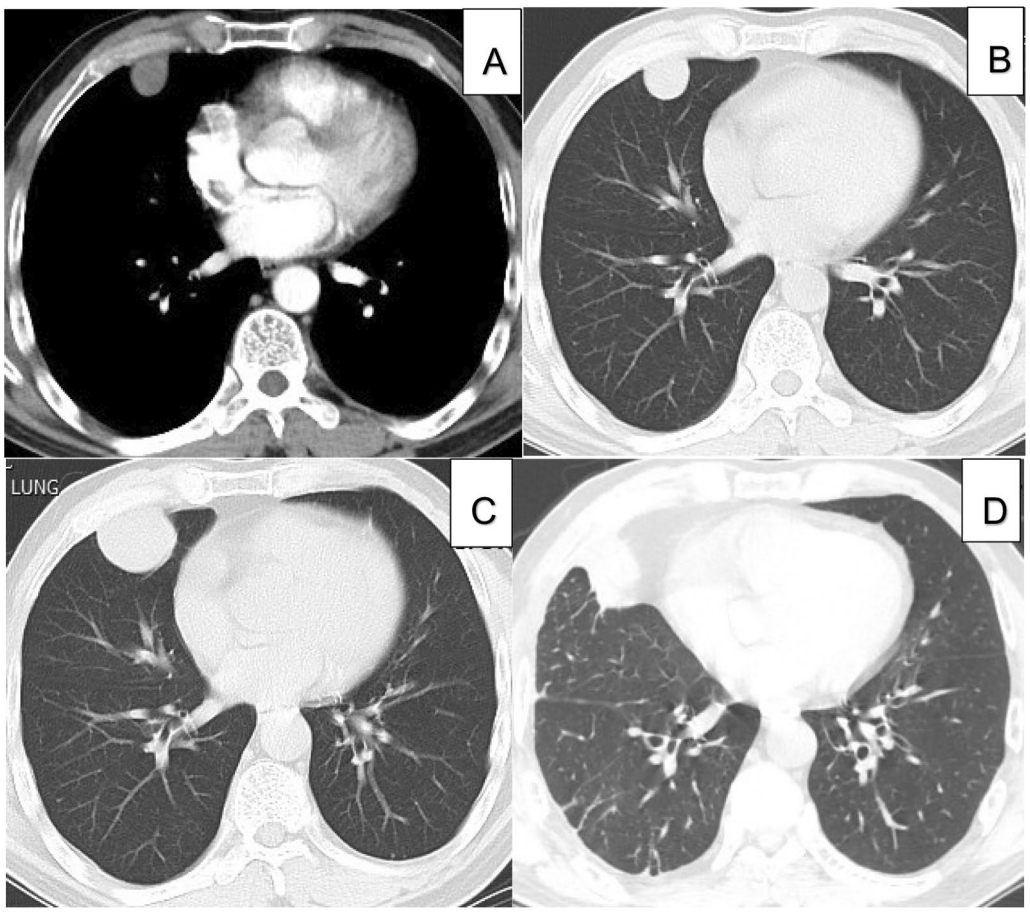

Fig. 1 Computed tomography images of PPM. (2017.10.08) CT scan suggesting a nodule in the right middle lobe (**A,B**). (2023.11.06) Reexamination CT scan suggesting the subpleural nodule in the right middle lobe had grown larger, lesion being isolated solid nodules with smooth margins, and clear boundaries (**C**).(2024.01.05) CT scan performed one month after surgery showed that the patient's lungs are in good condition(**D**)

and mediastinum, which were carefully lysed with the use of ultrasonic shears. Upon meticulous dissection, a firm, well-circumscribed nodule, measuring approximately 2 cm in diameter, was identified within the right middle lobe; importantly, there was no visual evidence of invasion into surrounding structures, including the aorta, pericardium, diaphragm, or chest wall. Consequently, a wedge resection of the right middle lobe, encompassing the identified nodule, was performed. Intraoperative frozen section examination of the resected specimen using the rapid assessment method revealed a proliferation of spindle cells primarily arranged in a fascicular pattern. The tumor cells exhibited moderate cellularity with mild nuclear atypia; however, there was no evidence of mitotic figures or necrosis. Based on these intraoperative findings, a preliminary diagnosis of a spindle cell soft tissue borderline tumor was favored. Routine paraffin section: Spindle cell soft tissue tumor (located in the right lung measuring 3.5 cm×3 cm×3 cm) and needs further immunohistochemical examination to be classified. Subsequent immunohistochemical staining showed positive results for epithelial membrane antigen (EMA), progesterone receptor (PR), CD56, vimentin (VIM), and Ki-67 (with an approximate 10% positive staining index). Notably, the tumor cells tested negative for pan-cytokeratin (CK-Pan), CD34, Bcl-2, signal transducer and activator of transcription 6 (STAT6), desmin, thyroid transcription factor 1 (TTF-1), and chromogranin A (CgA) (see Fig. 2). Taken together, these histopathological and immunohistochemical findings culminated in a definitive diagnosis of primary pulmonary meningioma. The surgery went smoothly, however, the patient developed a mild postoperative pulmonary infection, presenting with a productive cough. A follow-up CT on the second postoperative day showed inflammatory exudate and a small amount of pleural effusion. Sputum culture revealed the presence of Acinetobacter baumannii, and there was continued drainage from the thoracic tube exceeding 100 ml per day, which delayed the removal of the chest tube. The patient was treated with piperacillin-tazobactam for the infection, and the chest tube was removed once the output decreased significantly on postoperative day 4. The sixth-day sputum culture returned negative, and the patient was subsequently discharged. Follow-up CT scans are scheduled annually, with no recurrence or metastasis detected thus far.

Discussion

Primary pulmonary meningioma (PPM) is an uncommon condition with just over 50 cases reported in the literature. The pathogenesis of PPM remains unclear, potentially arises from displaced embryonic arachnoids cells that are isolated outside the dura mater. These cells may migrate along developing nerves or blood vessels passing through cranial openings [3], or they might originate from minute pulmonary meningothelial-like nodules [4, 5].

This disease is most commonly seen in middle-aged and elderly people, more often in females, with most patients being asymptomatic, discovered incidentally during physical exams or treatment of other diseases. A small number of patients may present with symptoms such as cough, expectoration, chest tightness, and shortness of breath due to large tumor size compressing lung tissue, causing lung infection or pleural effusion. Patients with tumors located at the hilum might present with hemoptysis. Most primary pulmonary meningiomas (PPM) on CT imaging appear as isolated or solitary solid nodules with smooth margins, and identifiably clear boundaries. A few may present as multiple nodules, with those having multiple nodules possibly indicating malignancy and invasiveness. In some cases, lesions are observed as ground-glass opacities (GGOs), making them challenging to differentiate from early lung cancer, which often exhibits spiculation, lobulation, vascular traversing, or pleural indentation [5–10].Benign PPM typically appears as round masses or GGOs with clear demarcation from surrounding lung tissue, sometimes accompanied by calcifications, but without lobulation, spicules, or pleural indentation. In contrast, malignant PPMs may show large necrotic areas, aggressive growth, invasion into muscles and surrounding connective tissues, involvement of pleura, esophagus, bronchi, and major blood vessels within the lung, as well as distant metastasis to bones and liver. The lesions are more prone to recurrence and metastasis after surgical excision. PET-CT has been employed to assist in determining the benign or malignant nature of meningiomas, with

(See figure on next page.)

Fig. 2 Pathologic findings of PPM. **A**: The tumor appears round or oval, with clear demarcation from the surrounding lung tissue. There is no evident capsule surrounding the tumor, and the cut surface exhibits a swirling or fascicular pattern.**B**: The tumor is clearly demarcated from the surrounding lung tissue (Hematoxylin and eosin staining; magnification,×100).**C**: Tumor cells are arranged in a swirling structure (Hematoxylin and eosin staining; magnification,×400).**D**: Tumor cells are positive for EMA, detected using the EnVision two-step method (magnification,×400).**E**: Tumor cells are positive for PR, detected using the EnVision two-step method (magnification,×400).**F**: Tumor cells are positive for vimentin (magnification,×400).**G**: Tumor cells show approximately 10% positivity for Ki-67 (magnification,×400)

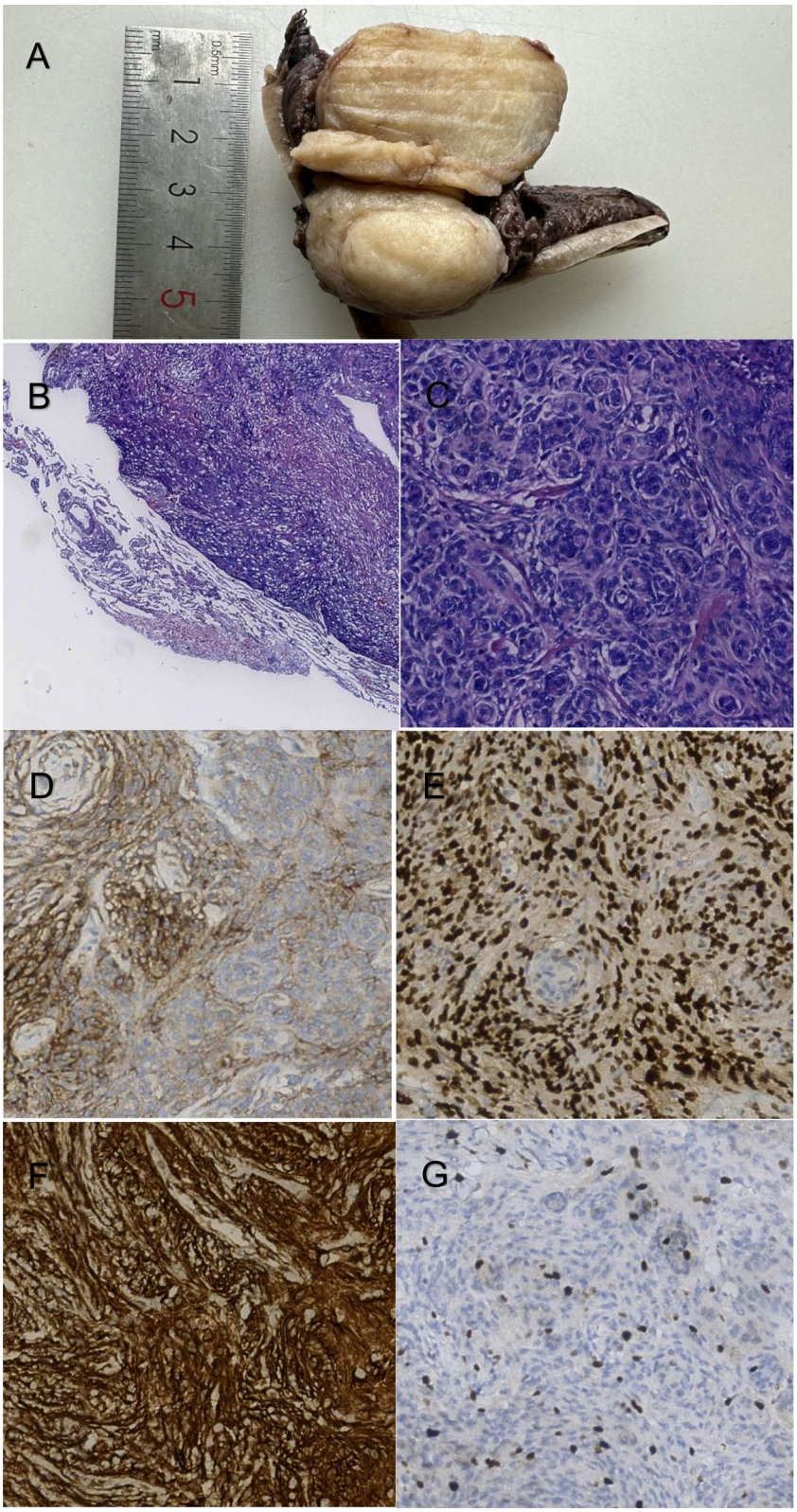

Fig. 2 (See legend on previous page.)

a sensitivity, specificity, and positive predictive value of 93%, 88%, and 92%, respectively. PET-CT can simultaneously display the metabolic state and anatomical location of PPM, but PET-CT cannot strongly confirm the presence of malignancy when diagnosing PPM and should not be overly relied upon [11].

The gross specimens of benign PPM are mostly solid masses, encapsulated, with a firm texture and a grayish-white cut surface, without bronchial or pleural invasion [8].Histologically, benign PPM morphology is indistinguishable from CNS meningiomas, with most being of the transitional type, fibrous type less common, and epithelial type rarest. Various histological forms have been reported, with cells generally showing no atypia and no invasion of the pleura or trachea observed.Tumor cells are usually spindle-shaped, polygonal, or oval, arranged in nodular and whorled patterns, with no evidence of mitosis. There have also been reports of psammoma bodies within the tumor tissue [8]. In malignant PPM under a microscope, features of atypical meningioma are visible, including structural loss, mild nuclear polymorphism, up to 15 mitotic figures per HPF, focal prominent nucleoli, and invasion of adjacent tissues such as the visceral pleura, esophageal smooth muscle, large blood vessel walls, pulmonary hilum lymph nodes, and bronchial cartilage [2].

Immunohistochemical markers are EMA-positive, VIM-positive (vimentin-positive), some cases CD34(+), with electron microscopy showing finger-like projections and desmosome connections [12, 13]. Primary pulmonary meningioma (PPM) must be differentiated from the following diseases: 1. Solitary Fibrous Tumor: The tumor cells vary in density, appearing as "patternless patten" with interstitial collagen fibers and branching staghorn vessels. Tumor cells are CD34, BCL-2, and STAT6 positive, and form a specific NAB2-STAT6 fusion gene. 2. Inflammatory Myofibroblastic Tumor: The tumor is composed of fibroblasts or myofibroblasts arranged in fascicles or sheet-like patterns, accompanied by significant plasma cell and lymphocyte infiltration. Immunohistochemically, it expresses vimentin and SMA, with ALK expression in half of the cases and CK expression in one-third. 3.Meningothelioid Nodules: These lesions share similar morphology and immunophenotype with PPM, but are typically small (1–3 mm) and perivenular pattern of growth. In contrast to meningiomas, they lack a solid growth pattern and a sharply circumscribed border. 4. Spindle Cell Carcinoid: Tumor composed of spindle cells arranged in fascicles, expressing NSE, CgA, and other neuroendocrine markers. 5. Spindle Cell Carcinoma: The tumor cells are more atypical, with prominent nucleoli, dark-staining nuclei, and irregular bundle-like or sheet-like arrangement, lacking typical meningioma structures and cellular features, and not expressing meningioma-related immunomarkers. 6. Metastatic Lung Tumors: These are manifested radiographically as multiple well-demarcated lung nodules and are typically differentiated by immunohistochemistry. However, CNS meningioma metastasis should be ruled out before diagnosing PPM [8]. Although primary pulmonary meningioma is a rare tumor, difficult to diagnose definitively, clinically and radiologically, most cases are benign with a good prognosis, and the surgical resection method of choice is usually wedge resection. A small proportion of malignant cases, due to the invasiveness of the tumor, require lobectomy and adjuvant radiotherapy and chemotherapy.

We made significant efforts to gather all reported cases and analyses related to primary pulmonary meningioma, totaling 52 articles, excluding duplicates. After careful review, 55 cases were documented, including our case, totaling 56. We analyzed these cases based on the publication date, geographic location, and patient demographics such as gender, age, and tumor location (see Table 1). We observed an increase in reported cases in recent years, with 7 cases reported between 2022 and 2024, and including our case, a total of 8 cases in less than two years (see Table 2). This might be associated with several factors: 1. An increasing incidence rate of ectopic meningiomas, especially primary pulmonary meningiomas. 2. An increase in public awareness of pulmonary diseases, particularly lung cancer, and the widespread use of low-dose CT scans. 3. Improved pathological diagnostic capabilities, leading to better recognition of the disease by pathologists and clinicians. Moreover, the incidence of PPM seems to be regionally concentrated, with the highest number of cases reported in Asia (40 cases, representing 71.43% of all cases), particularly in China and Japan, and with Europe following. Italy reported the most cases in Europe (see Table 3). The majority of cases involve women, with a female-to-male ratio of 35:21, and the average age at diagnosis is 55.03 years. Most tumors are solitary and can manifest as ground-glass nodules, occurring in multiple lung lobes, occasionally involving the mediastinum and pleura with multiple nodules. Out of 56 patients, 8 exhibited multiple intrapulmonary nodules or multiple nodules involving mediastinum and pleura, and one patient presented with multiple cystic lesions. Eight patients exhibited GGO nodules. Among 55 patients, 49 were benign PPMs, with the pathological types mainly being transitional meningioma and fibrous type, and tumor sizes ranging from 0.4 to 20.0 cm. There were five malignant PPMs, with the smallest diameter being 1.2 cm, mostly involving extensive thoracic involvement (see Table 1).Additionally, one patient was diagnosed with fibrous benign meningioma through surgery in 2015 due to a right upper lobe nodule, but in 2016,

Table 1 Relevant case reports and data

Author	Date[a]	Number[b]	Gender[c]	Age	Location[d]	Size(cm)	Therapy	Benign/ Malignant	Country
Kemnitz [19]	1982	1	F	59	RLL	4.0	Wedge resection	Benign	Germany
Strimlan [20]	1988	1	F	74	LLL	1.7	Lobectomy	Benign	United States
Kodama [21]	1991	1	M	53	LUL	2.6	Segmentectomy	Benign	Japan
Ueno [22]	1998	1	F	61	3 right, 2 left side(multiple)	1.0–2.0	Wedge resection	Benign	Japan
Perrot [23]	1999	1	M	57	RLL	0.8	Wedge resection	Benign	Switzerland
Gomez [24]	2002	1	M	58	LLL	2.2	Not mentioned	Benign	Spain
Alfredo [25]	2002	1	M	56	LUL	2.0	Lobectomy	Benign	Italy
Li [26]	2002	1	M	50	RLL	7.0	Lobectomy	Benign	China
Comin [27]	2003	1	M	33	LUL	2.0	Wedge resection	Benign	Italy
Tian [28]	2004	2	M 1/F1	50/41	RLL/right lung	7.0/20	Segmentectomy/Not mentioned	Benign	China
Picquet [29]	2005	1	F	54	LLL	1.4	Wedge resection	Benign	France
Zhang [13]	2005	1	M	72	LUL	1.9	Wedge resection	Benign	China
Van Der Meij [30]	2005	1	F	40	Right hilar region	5.0	Lobectomy	Malignant	Netherlands
Meirelles [31]	2006	1	M	48	RLL	1.5	Lobectomy	Benign	United States
Incarbone [32]	2008	1	M	24	RUL	2.4	Wedge resection	Benign	Italy
Izumi [33]	2009	1	F	18	LUL (hilar region)	3.0	Lobectomy	Benign	Japan
Zhang [34]	2009	1	F	10	RLL	8.0	Lobectomy	Benign	China
Yang [35]	2009	1	M	44	RML	Not mentioned	Not mentioned	Benign	China
Wang [12]	2009	1	M	50	RLL	7.0	Lobectomy	Benign	China
He [36]	2010	1	M	46	RML	2.2	Lobectomy	Benign	China
Wang [37]	2010	1	F	23	RUL	3.5	Lobectomy	Benign	China
Masago [5]	2012	1	M	76	LUL	0.8	Wedge resection	Benign	Japan
Zong [38]	2013	1	F	35	LUL	3.0	Wedge resection	Benign	China
Lepanto [39]	2014	1	F	60	LUL	1.7	Wedge resection	Benign	Italy
Chiarelli [40]	2015	1	M	68	RML	5.5	Wedge resection	Benign	Italy
Caobelli [18]	2015	1	M	68	Left lung	Extensive investment	Non-surgical	Malignant	Italy
Wang [41]	2015	1	M	68	RLL	8.0	Lobectomy	Benign	China
Lopez [42]	2016	1	F	79	RLL	Not mentioned	Not mentioned	Benign	Brazil
Kim [43]	2016	1	F	61	RUL	2.5	Lobectomy	Benign	South Korea
Zhang [11]	2016	1	M	46	2 right side(multiple)	1.0–4.0	Wedge resection	Benign	China
Satoh [44]	2017	1	F	84	1 right, 1 left side(multiple)	0.6–2.5	Non-surgical	Benign	Japan
Ong [45]	2017	1	F	65	RML	1.9	Lobectomy	Benign	Singapore

Table 1 (continued)

Author	Date[a]	Number[b]	Gender[c]	Age	Location[d]	Size(cm)	Therapy	Benign/ Malignant	Country
Zhang [8]	2018	4	M0/F 4	54(average age)	3 ground glass nodules (specific locations not detailed), 1 LLL	0.5–1.5	Wedge resection	Benign	China
Ohashi [46]	2019	1	F	60	RLL	2.0	Segmentectomy	Benign	Japan
Wang [47]	2019	1	F	64	Multiple cystic lesions	3.4	Wedge resection	Benign	China
Žulpaitė [1]	2019	1	F	43	LUL	4.5	Wedge resection	Malignant	Lithuania
Cimini [14]	2019	1	M	80	RUL,LUL(multiple)	1.4/1.2	Lobectomy	Benign/Malignant	Italy
Minami [15]	2020	1	F	67	LLL	Not mentioned	Wedge resection	Malignant	Japan
Ni [48]	2020	2	M1/F1	66/47	LLL/RUL	3.2/2.8	Wedge resection	Benign	China
Zhang [9]	2020	1	F	71	RUL	0.6	Segmentectomy	Benign	China
He [49]	2021	1	F	71	Right lung and pleura multiple nodules (multiple)	5.6	Non-surgical	Malignant	China
Li [50]	2021	1	F	72	RUL	0.8	Segmentectomy	Benign	China
Dong [7]	2021	1	F	66	RUL (ground glass nodule)	1.0	Segmentectomy	Benign	China
Tian [6]	2022	1	F	54	LLL(ground glass nodules) (multiple)	0.5–1.0	Lobectomy	Benign	China
Huang [10]	2022	1	F	64	RUL,RLL,LLL (multiple)	0.4–0.8	Wedge resection	Benign	China
Li [2]	2022	1	F	53	RLL	2.0	Wedge resection	Benign	China
Xu [51]	2023	1	F	47	LLL	7.4	Lobectomy	Benign	China
Feng [16]	2023	1	F	55	LLL	9.5	Wedge resection	Benign	China
Ma [52]	2024	2	M0/F2	45/53	LUL/LLL	1.5–3.0	Wedge resection	Benign	China
Report in this study	2024	1	M	57	RML	3.5	Wedge resection	Benign	China

[a] Publication date; [b]Number of Cases reported; [c]F: female; M:male; [d]Tumor location, RLL: right lower lobe; RUL:right upper lobe;RML:right middle lobe; LUL: Left upper lobe; LLL: Left lower lobe

Table 2 Number of case reports by year with patient gender and average age

Year	Number of reported cases	Female	Male	Average age (Years)
1982–1991	3	2	1	62.00
1992–2001	2	1	1	59.00
2002–2011	17	6	11	42.18
2012–2021	26	19	7	62.81
2022 to date	8	7	1	53.50
Sum(Cases)	56	35	21	55.03

another nodule was found in the left upper lobe, which was pathologically confirmed as anaplastic meningioma (malignant) after surgery [14].

There were 10 patients with PPM cases who had "18F-FDG PET/CT" imaging data, with lesion sizes ranging from 0.5 cm to 9.5 cm and uptake values ranging from none to SUVmax 12.9. Among these, four patients had

Table 3 Number and proportion of case reports by country and region

	Country	Number of Cases	Total(Cases)	Percentage(%)
Asia	China	31	40	71.43%
	Japan	7		
	South Korea	1		
	Singapore	1		
Europe	Italy	7	13	23.21%
	Germany	1		
	France	1		
	Spain	1		
	Switzerland	1		
	Netherlands	1		
	Lithuania	1		
America	United States	2	3	5.36%
	Brazil	1		

PET-CT findings initially suspected as malignant, but the postoperative pathology confirmed them as benign meningiomas. The 18F-FDG uptake SUVmax ranged between 3.5 and 12.9 g/mL. There was also one late-stage patient who was confirmed to have multiple bone metastases via PET-CT, including in the frontal bone, mandible, left scapula, ribs, vertebrae, pubis, left femur, and sternum [15].Another patient had undergone PET-CT scans twice in 2015 and 2016 for lung nodules, with the first nodule located in the right upper lobe, approximately 14 mm in diameter, and the PET-CT scan showed abnormal metabolism, with an SUVmax of 4.63 g/mL, suspected of being metastatic cancer. However, the final pathological diagnosis confirmed it to be fibrous benign meningioma. The second nodule was in the left upper lobe, with a diameter of 12 mm, and the PET-CT showed abnormal metabolism, with an SUVmax of 2.46 g/mL, eventually diagnosed as anaplastic meningioma (malignant) [14]. These results indicate that 18F-FDG PET/CT findings in PPMs lack specific characteristics, and SUVmax levels alone cannot evaluate the nature of PPMs, suggesting that the increase in SUVmax is due to relatively rapid tumor growth and unrelated to tumor size [16, 17]. There was also a report of a patient who underwent a 68Ga-DOTATOC PET/CT scan, with the 68Ga-DOTATOC maximum intensity projection (MIP) image showing the presence of somatostatin receptor overexpression in the pathological tissue of the left lung and extensive pleural involvement. The pathological diagnosis confirmed it as an aggressive primary pulmonary meningioma [18].

Since it is difficult to make a definitive diagnosis based on clinical, CT imaging, and PET-CT findings, surgery remains the optimal choice for the diagnosis and treatment of PPM. Of the 56 cases reported, 27 patients underwent pulmonary wedge resection, 6 patients underwent segmental resection, and 16 patients underwent lobectomy. The remaining 7 patients either did not undergo surgery or had no records of surgery. The outcomes of surgical treatment were generally good, with only three cases of recurrence, although continued follow-up is required.During surgical treatment, intraoperative rapid pathology is required to determine whether the tumor is completely resected. The choice of surgical approach is crucial. For benign primary pulmonary meningioma (PPM), thoracoscopic wedge resection or segmentectomy is generally recommended, while lobectomy should be considered cautiously. Lobectomy should not be performed solely based on a preoperative suspicion of malignancy, unless the tumor is very large, centrally located, or involves the hilum, making local resection difficult. Intraoperative rapid pathology can help prevent overtreatment; however, distinguishing between benign and malignant PPM using frozen section analysis is generally challenging, necessitating further immunohistochemical evaluation. This presents difficulties for surgical decision-making. If the resection margin is insufficient, a second surgery for extended resection or adjuvant radiotherapy and chemotherapy may be required for consolidation. We summarized the treatment process for suspected pulmonary PPM lesions based on lung cancer management protocols and created the following flowchart for PPM management (see Fig. 3).

Conclusion

Primary pulmonary meningioma is a rare tumor that occurs in sites similar to lung cancer. Most cases are solitary, presenting as ground-glass nodules (GGO), and can occur in multiple lobes, involving the mediastinum and pleura with multiple nodules. Clinical and radiological diagnoses are often challenging, especially distinguishing from primary lung cancer. Surgery remains the optimal choice for the diagnosis and treatment of PPM. Most cases are benign with a good prognosis, and wedge resection is usually the preferred surgical approach. A small proportion of malignant cases may require lobectomy and adjuvant radiotherapy and chemotherapy due to tumor invasiveness.

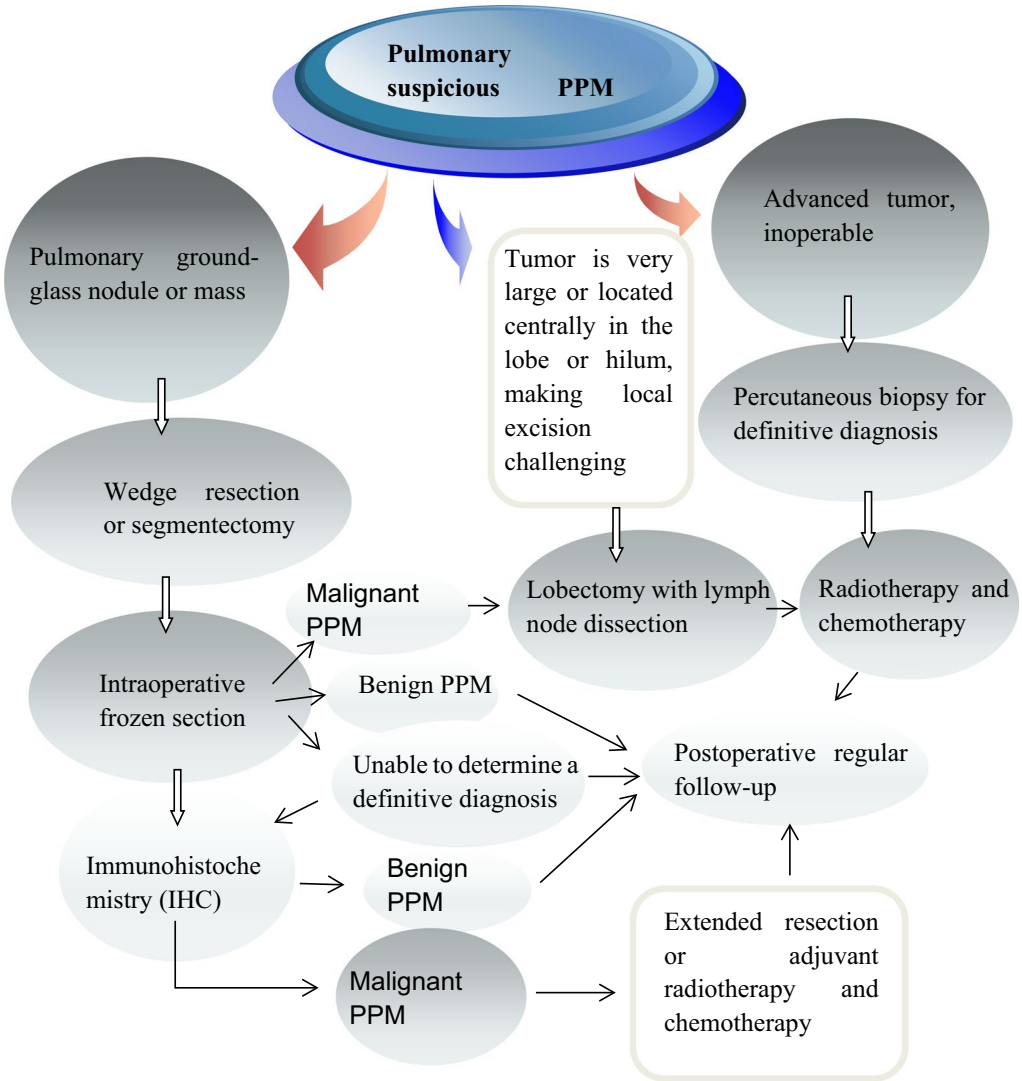

Fig. 3 A treatment flowchart for suspected PPM lesions, following lung cancer management protocols

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13019-024-03259-9.

Additional file 1.
Additional file 2.
Additional file 3.
Additional file 4.

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Author contributions
Jun Cheng drafted the manuscript. Jun Cheng, Chunfen Guo participated in the revision of the manuscript for important intellectual content. Chunfen Guo made pathological sections and provided pathological pictures. All authors read and approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Written informed consent was obtained from the patient to participate in this case report.

Consent for publication
We obtained written informed consent for clinical details and clinical images from the patient. A copy of the consent form is available for review by the journal editor.

Competing interests
The authors declare no competing interests.

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