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CASE REPORT

A rare resected case of pulmonary rhabdomyosarcoma

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Abstract
Rhabdomyosarcoma is a well-known neoplasm in children that frequently occurs in the extremities, the head and neck region, and the genitourinary tract. To the best of our knowledge, pulmonary primary rhabdomyosarcoma in adults is exceedingly rare, and few resected cases have been reported. We report a case of pulmonary primary rhabdomyosarcoma that was surgically resected then treated with adjuvant chemotherapy (vincristine, actinomycin-D and cyclophosphamide). At 9 months after surgery, the patient is free from disease. Although the prognosis of rhabdomyosarcoma is unfavorable, surgical resection and adjuvant therapy could be a potential treatment strategy for pulmonary primary rhabdomyosarcoma.

Keywords Rhabdomyosarcoma · Surgery · Lung

Introduction

Primary rhabdomyosarcoma (RMS) is a common soft tissue malignancy in children. The most commonly reported sites of occurrence are the extremities, the head and neck region, and the genitourinary tract [1]. However, few cases have been reported in the pulmonary region, as the striated muscle, in which RMS is generally originates, is not naïve in the lungs [2]. Moreover, cases of primary pulmonary RMS arising in adults are exceedingly rare [3]. Because of its extreme rarity, there is no established treatment strategy. In this report, we described an extremely rare case of pulmonary RMS that was successfully treated by surgery and subsequent adjuvant chemotherapy.

Case

A 66-year-old woman presented to a local hospital with dyspnea on exertion that had persisted for 6 months. She had no special history implying genetic disorder. She was an ex-smoker with a Brinkman's index of 1410. A chest X-ray film obtained on presentation showed a large mass in the right lower lung and she was referred to the outpatient department of the hospital. On a blood analysis, the complete blood count, biochemistry and serum tumor marker levels were within normal limits. Electrocardiography was normal, and the patient's pulmonary function was categorized as chronic obstructive pulmonary disease with a forced expiratory volume in 1 s of 1.20 L.

Contrast-enhanced computed tomography (CE-CT) showed a large mass of 64 × 54 × 49 mm in size without enhancement, located in the right lower lobe, and enlarged interlobar and mediastinal lymph nodes (Fig. 1a–c). A whole-body positron emission tomographic computed tomography scan (PET-CT) with ^{18}F-fluorodeoxyglucose (FDG) showed the high accumulation of FDG in the tumor and the enlarged lymph nodes. No other sites of FDG accumulation were detected in the body (Fig. 1d). Transbronchial biopsy was then performed to obtain a specimen of the tumor.

The histological examination of the biopsy specimen indicated that the tumor was RMS. Applying the case to the classification of the Intergroup Rhabdomyosarcoma Study (IRS)-V, this case was clinically classified as unfavorable site, T1bN1M0 and Stage III. However, given that RMS is extremely rare in adults, we planned to perform surgical resection first to make an accurate diagnosis, and as treatment. Since the interlobar lymph nodes showed intranodal swelling and did not infiltrate to the surrounding tissue, right

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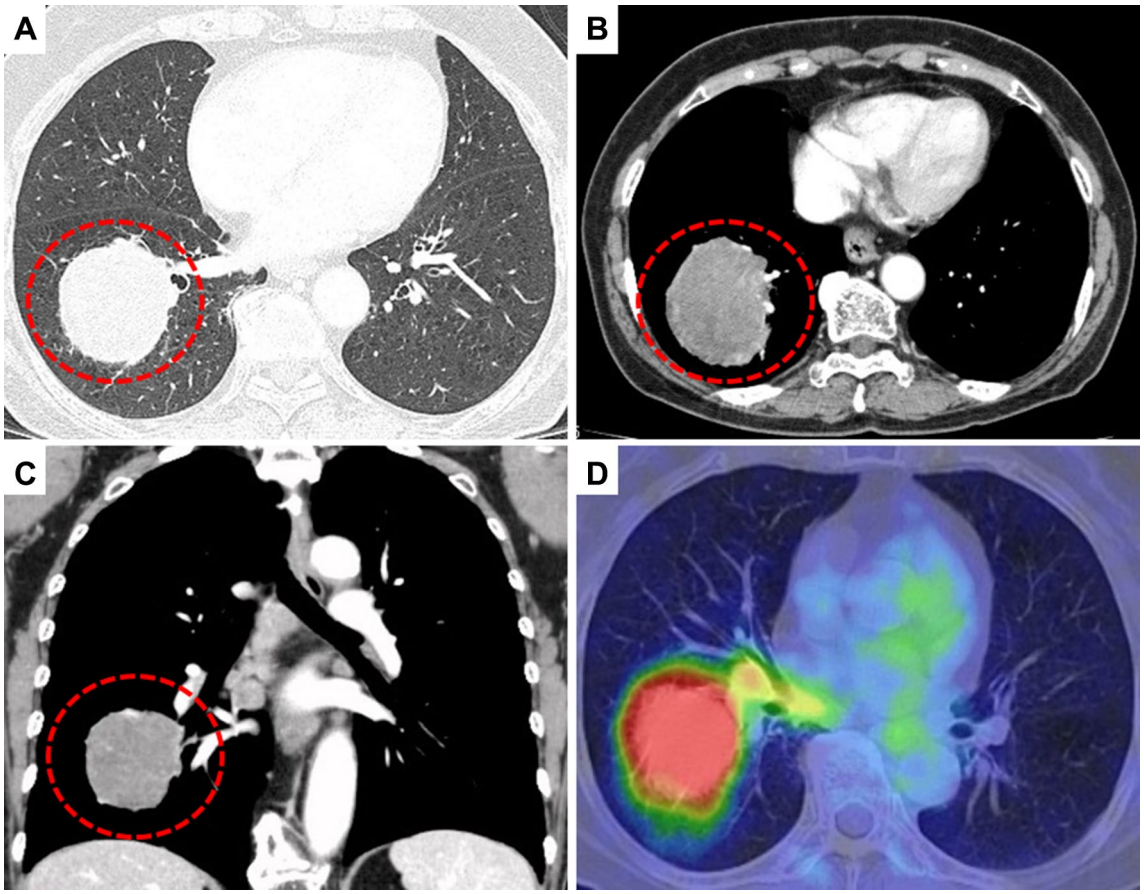

Fig. 1 **a**–**c** Contrast-enhanced computed tomography (CE-CT) showed a large mass of 64 × 54 × 49 mm in size in the right lower lobe (red-dot circle) and enlarged interlobar and mediastinal lymph nodes. **d** Positron emission tomographic computed tomography (PET-CT) with ^{18}F-fluorodeoxyglucose (FDG) showed the high accumulation of FDG in the tumor and enlarged lymph nodes

lower lobectomy was performed followed by hilar and mediastinal lymph nodal dissection. The patient was discharged with no postoperative complications.

The tumor-resected specimen in the right lower lobe measured 60 × 35 × 40 mm. Grossly, the cut surface of the tumor was well-circumscribed solid and reddish, with areas of necrosis and hemorrhage (Fig. 2a). Microscopic observation showed solid sheets of the small round blue cells supported by delicate fibrovascular stroma (Fig. 2b, c). The tumor was immunohistochemically positive for desmin and myogenin (Fig. 2d, e). Based on the microscopic and immunohistochemical findings, the tumor was diagnosed as alveolar type RMS. The diagnosis of carcinosarcoma seemed to be unlikely as obvious carcinoma components such as squamous cell carcinoma or adenocarcinoma were not detected in the specimen. Among the dissected lymph nodes, only one regional interlobar lymph node showed metastasis. The other lymph nodes, including the mediastinal lymph nodes were negative for malignancy and showed reactive enlargement associated with inflammation. Final pathological examination revealed that the case was classified as Group IIb and alveolar type, intermediate risk group by IRS-V risk classification.

After surgical resection, the patient received eight courses of adjuvant chemotherapy (vincristine 1.5 mg/body on day 1,8 and 15, actinomycin-D 1.5 mg/m^2 on day 1 and cyclophosphamide 1200 mg/m^2 on day 1, q3week). At 9 months after surgery, she is alive and free from disease.

Discussion

RMS is a soft tissue sarcoma, and the most common malignancy in children, but is relatively rare in adults. Primary pulmonary RMS is extremely rare, because RMS generally originates from the pluripotent primitive mesenchyme with capacity for differentiation into neurogenic and myogenic elements. McDonald et al. reported the first case of primary pulmonary RMS in 1939 [4]. In the English literature, there have been only three resected cases of pulmonary RMS in adult [5–7]. (Table 1).

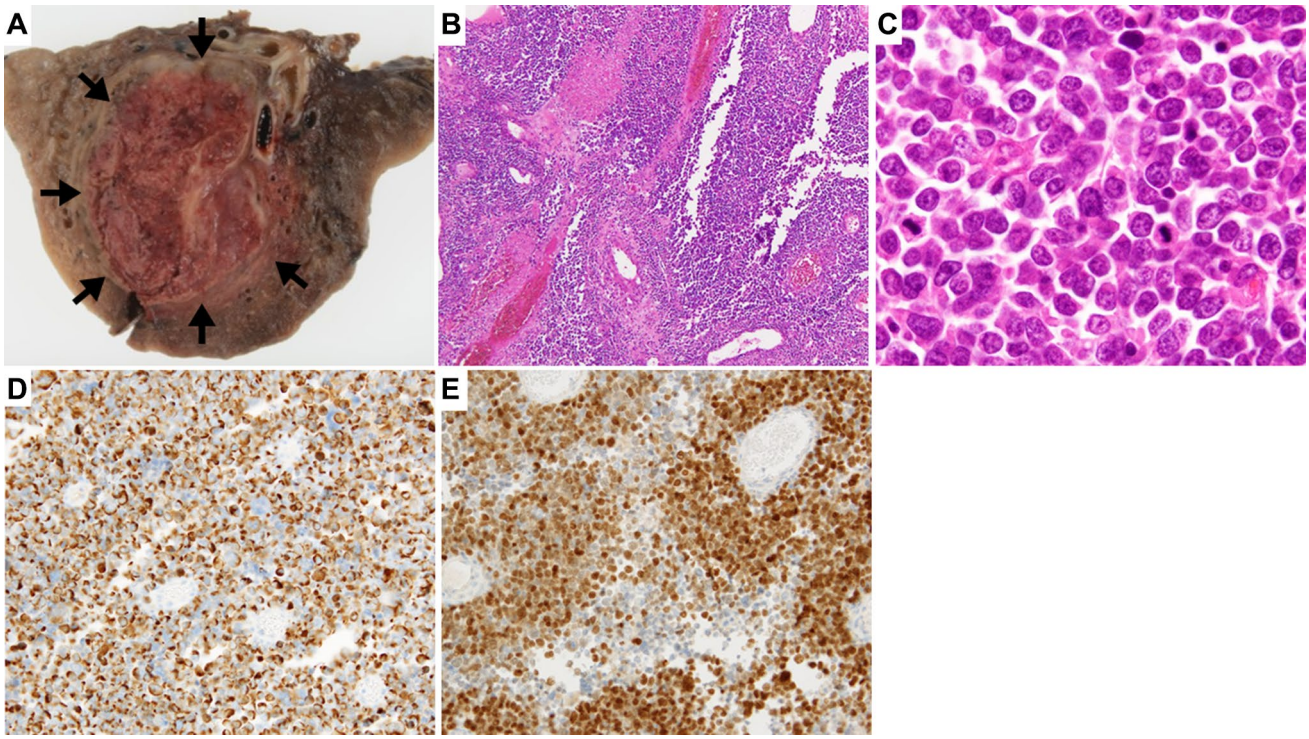

Fig. 2 **a** The cut surface of the tumor (outlined with black arrows) was reddish indicating necrosis and hemorrhage. **b** Low power view (**c**) and in high power view of the tumor in hematoxylin and eosin staining showed solid sheets of the small round blue cells supported by delicate fibrovascular stroma. **d** The specimen was immunohistochemically positive for desmin (**e**) and myogenin

Table 1 Resected cases of primary pulmonary rhabdomyosarcoma

Author (year)	Age	Sex	Nodal involvement	Treatment	Survival after surgery	Prognosis	
Avagnina (1984)	43	F	N/A	S	23 months	Metastasis in small bowel (resected)	Alive
Comin (2001)	62	M	Yes	S + RT	9 months	No recurrence	Alive
Choi (2009)	44	M	No	S + CT	Referred to oncologists	N/A	N/A
Our case	73	F	Yes	S + CT	9 months	No recurrence	Alive

N/A not available, *S* surgery, *S + CT* chemotherapy following surgery, *S + RT* radiation therapy following surgery

There are two possible reasons for RMS originating in the lungs. First, heterotopic aberrant striated muscle can cause pulmonary RMS, similar to the histogenesis of pulmonary sequestration. This theory is consistent with the fact that pleuropulmonary blastomas in such lesions have the potential to evolve into high-grade primitive sarcomas [8]. Second, the primitive mesenchymal cells in the lung interstitium or bronchial wall can acquire myoblastic differentiation through increasing the expression of muscle-specific microRNAs such as microRNA (miRNA)-1, miRNA-133 a/b, and miRNA-206 [9]. This hypothesis might explain the origin of pulmonary RMS in the present case. Needless to say, it is important to search the whole body for a primary sarcoma at sites other than the lung before a diagnostic decision is made.

Alveolar RMS, which is one of the RMS subtypes and usually appears in adults, have a higher capacity of nodal metastasis as compared to the other subtypes [10, 11]. Recent studies have revealed that two common chromosomal alternations in alveolar RMS are associated with occurrence of RMS; *t*(2;13)(q35;q14) PAX3/FOXO1, and *t*(1;13)(q36;q14), PAX7/FOXO1. In detail, PAX3/FOXO1 and PAX7/FOXO1 transcripts are present in 55% and 22% of alveolar RMS cases, respectively, while the remaining alveolar RMS cases are negative for the fusion gene [9, 12]. It has been demonstrated that the prognosis of alveolar RMS with

PAX3/FOXO1 is much worse than that with PAX7/FOXO1 [13]. Moreover, the prognosis of fusion-negative alveolar RMS is better than that of fusion-positive RMS [14]. In this case, genetic changes, such as PAX3/FOXO1 and PAX7/FOXO1 were not detected, indicating that the prognosis of our case could be more favorable.

Among the previously reported cases of pulmonary RMS, most patients died without resection, because of its advanced stage and rapid tumor progression. Two patients who underwent surgical resection and subsequent chemotherapy or radiotherapy survived with freedom from recurrence [6, 7] (Table 1). Thus, although the follow-up period was short, surgical resection and adjuvant therapy could be a treatment option for pulmonary RMS in adults. Even in cases of children, surgical resection could be initially considered for accurate diagnosis and treatment because most of the pulmonary RMS are associated with congenital cystic malformation which requires surgical resection [2].

In the present case, we first attempted to introduce chemotherapy as RMS has been considered to be highly sensitive to chemotherapy. However, we opted for surgery because we were uncertain as to whether the tumor was actually RMS. Even though the transbronchial biopsy specimen was diagnosed as RMS, primary RMS of the lung is extremely rare in adults, and the possibility of carcinosarcoma with an RMS element could not be denied. The examination of the completely resected tumor revealed RMS, with no mediastinal lymph node metastasis. The patient was able to tolerate adjuvant chemotherapy after surgical resection.

The limitation of our case was that fusion gene could not be identified. Even though about 20% cases of alveolar RMS exhibits fusion-negative, primary pulmonary RMS is so rare that the detection of fusion gene should be needed for definitive diagnosis.

In conclusion, we experienced an extremely rare resected case of RMS that originated in the lung. Multimodal therapy including surgery and chemotherapy may lead to a beneficial outcome.

Compliance with ethical standards

Conflict of interest The authors have declared that no conflict of interest exists.

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