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CASE REPORT

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Ruptured pulmonary arteriovenous fistula causing hemothorax in a patient with hereditary hemorrhagic telangiectasia: A case report

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A 56-year-old male patient was admitted to our hospital with respiratory distress persisting for half a month as the chief complaint. The patient developed dyspnea following a heated argument, and his symptoms progressively worsened over time. Upon admission, he was unable to tolerate light physical activity due to shallow breathing. Vital signs revealed a blood pressure of 103/68 mmHg, heart rate of 85 bpm, and oxygen saturation level of 87% with 3 L/min of oxygen inhalation. Pulmonary computed tomography (CT) displayed massive pleural effusion on the left side, while computed tomography angiography (CTA) of the pulmonary identified a large pulmonary arteriovenous fistula in the lower lobe of the left lung and a small arteriovenous fistula in the upper lobe of the right lung (Figure 1). Diagnostic thoracentesis suggested hemorrhagic pleural effusion (pleural fluid routine: total erythrocyte count: 42,200 10^6/L).

A medical diagnosis of a ruptured arteriovenous fistula resulting in a hemothorax was considered. The patient's medical history revealed a previous episode of epistaxis. Coagulation parameters and platelet function were within the normal range. He did not undergo an electronic nasopharyngoscope examination or receive treatment. Her father died of a cerebral hemorrhage, the etiology of which could not be definitively determined upon retrospective review. According to Curacao's diagnostic criteria, the patient exhibited recurrent spontaneous rhinorrhea and visceral involvement, manifesting as pulmonary arteriovenous malformation, and a diagnosis of hereditary hemorrhagic telangiectasia (HHT) was suspected. Subsequent genetic testing identified mutations in the ENG gene, thereby validating this diagnosis. The patient's family was advised to undergo further family lineage verification.

Following this, the patient underwent a head-enhanced magnetic resonance imaging (MRI) scan and whole abdomen-enhanced CT to evaluate the potential involvement of other internal organs. Head MRI illustrated evidence of subacute lacunar cerebral infarction, while the abdominal CT did not reveal any additional internal organ involvement.

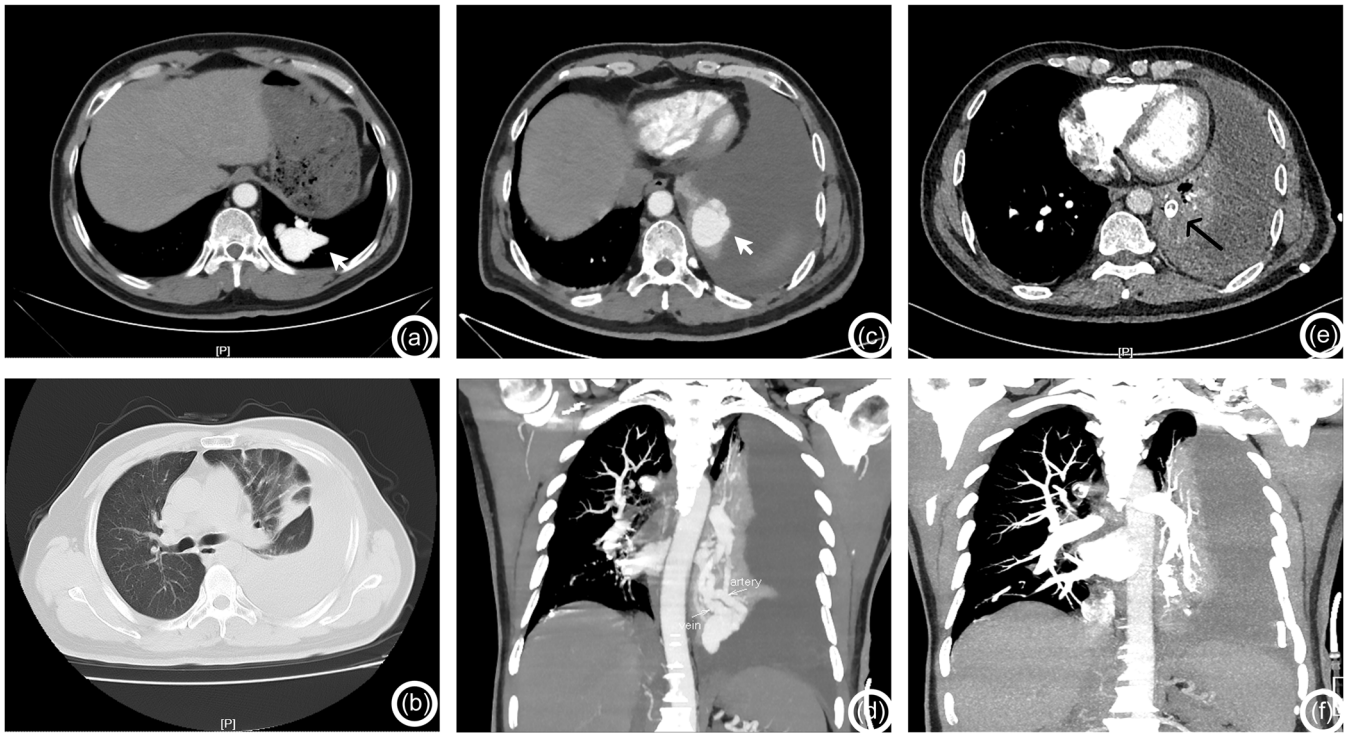

FIGURE 1 Patients' computed tomography images during hospitalization. (a) Patient underwent contrast-enhanced CT scans of the abdomen, revealing tortuous vascular shadows in the lower lobe of the left lung, indicative of pulmonary arteriovenous fisstula; (b) chest CT was performed following admission, exposing significant fluid accumulation in the thoracic cavities, compressing the pulmonary tissue and promoting atelectasis; (c) (axial image), (d) (coronal image): CTA of pulmonary vessels delineated a tortuous course of the pulmonary artery in the lower lobe of the left lung, with luminal thickening, and a restricted contrast shadow measuring approximately 3.9×3.1 cm was visualized in the lower lobe of the left lung, communicating with the thickened pulmonary artery in the lower lobe of the left lung. Additionally, a prominent draining vein was observed, which converged into the left lower pulmonary vein; (e) (axial image), (f) (coronal image): Patient's CTA of the pulmonary artery was reviewed after interventional embolization, revealing a very dense visualisation of the spring coils, as presented in E.1.

During an in-hospital MDT consultation, the interventional department described the patient had a large pulmonary arteriovenous fistula associated with massive bleeding. However, DSA did not identify the bleeding source. Given the significant size of the arteriovenous fistula, achieving effective hemostasis via embolization was considered challenging.

Notably, the thoracic surgery department determined that the risk linked to surgical intervention was extremely high. The patient was currently hemodynamically stable with no ongoing signs of active bleeding, ascribed to the large amount of pleural fluid compressing the ruptured opening, resulting in temporary dynamic equilibrium. Of note, thoracotomy could have resulted in intraoperative hemodynamic instability or circulatory failure. While ECMO was regarded as a viable alternative to maintain circulatory stability during surgery, postoperative weaning from ECMO was challenging for this patient.

The patient's vital signs remained stable, and considering the risk of surgery and the possible economic burden, a decision was made to proceed with interventional embolization to seal the bleeding rupture.

The patient underwent blocker implantation under DSA on February 28, 2022, followed by closed chest drainage for 8 days after surgery. Postoperative chest X-ray depicted poor pulmonary reopening. On March 22, 2022, the patient was subjected to thoracoscopy-assisted removal of the accumulated blood and clots. During the procedure, active bleeding from the ruptured cystic mass in the lower lobe of the left lung was observed. Consequently, a left lower lung lobectomy was performed, lasting 3.5 h. Importantly, there were no postoperative complications. The patient satisfactorily recovered after surgery, and a dynamic review of the chest radiograph indicated good pulmonary reopening - (Figure 2). The patient was prepared for elective interventional pulmonary artery malformation embolization of the right upper lobe, with regular follow-up visits scheduled.

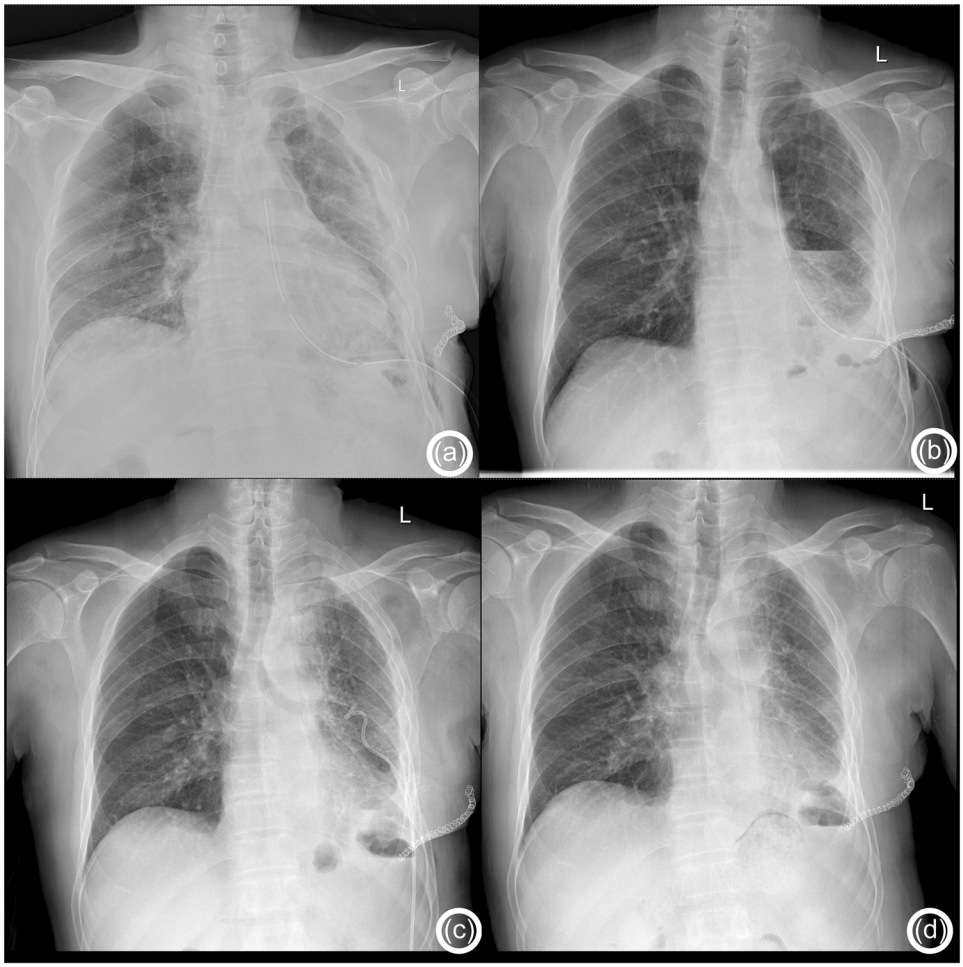

FIGURE 2 Following surgical intervention, the patient underwent digital diagnostic chest examination. (a) 2 days postoperatively; (b) 6 days postoperatively; (c) 12 days postoperatively; (d) 18 days postoperatively.

DISCUSSION

HHT is an autosomal dominant disorder characterized by abnormal capillary structure and endothelial cell function, with a prevalence estimated at 1/5000.[1,2] It primarily manifests as vascular malformations of the skin, nasal and gastrointestinal mucosa, brain, lung and liver, and other internal organs.

The diagnosis of HHT is typically made using the Curacao diagnostic criteria[3]: (1) rhinorrhea: presenting spontaneously and recurrent; (2) capillary dilatation: generally located in characteristic locations such as the fingers, mouth, nasal cavity, and lips; (3) internal organ involvement: arteriovenous malformations of the gastrointestinal system, lungs, brain, and spinal cord; (4) family history: first-degree relatives diagnosed with HHT based on the aforementioned criteria. Patients meeting three or more of the above-mentioned criteria can receive a definitive diagnosis; if only two criteria are fulfilled, the diagnosis is deemed suspicious; if less than two criteria are met, the diagnosis can be ruled out. However, when applying these diagnostic criteria, the patient's age should be taken into account, given that the signs and symptoms of HHT steadily manifest over time, with the majority of HHT patients meeting the diagnostic criteria after the age of 40 years. Moreover, in the clinical setting, the occurrence of missed diagnoses in adolescents and children should be considered. Similarly, in this study, patients were unable to be definitively diagnosed using these criteria owing to the absence of characteristic capillary dilation of the skin mucosa and a family history of the disease. Therefore, these populations are recommended to undergo genetic testing.[4]

HHT is associated with mutations in genes involved in the transforming growth factor-β (TGF-β) pathway, namely the endoglin-binding gene (endoglin, ENG) and the gene encoding the kinase 1-like activator receptor (active receptor, type II-like 1, AVRL1), associated with the occurrence of HHT type 1 and HHT type 2, respectively.[5] Less commonly mutated genes such as

SMAD4 and BMP9/GDF2 have also been reported to be associated with rare subtypes of HHT.[6]

It is worthwhile pointing out that HHT is a disease characterized by vascular dysplasia. Approximately 50% of patients with HHT present with pulmonary arteriovenous malformation (PAVM). A study performed in the United Kingdom described that 67% of patients with PAVM have confirmed HHT.[4] Moreover, pulmonary arteriovenous fistulas often present as hypoxia, hemoptysis, and other symptoms due to the impact of right-to-left shunts. Life-threatening complications include stroke, brain abscess, hemoptysis, and spontaneous hemothorax.

Spontaneous rupture of PAVM is rarely encountered and usually occurs in pregnant women.[7] The mechanisms underlying ruptured bleeding from PAVM during pregnancy are increased blood volume, cardiac output, and venous distensibility. These risk factors were not present in this patient. Indeed, the patient had a verbal altercation before the onset of the disease, potentially linked to sympathetic excitation, elevated blood pressure, and increased cardiac output following emotional distress.

The clinical symptoms of HHT patients with comorbid PAVM vary and depend on the size and location of the PAVM. Unlike other patients experiencing hypoxic symptoms due to the right-to-left shunt of PAVM, the primary cause of symptoms in this report was restrictive ventilatory dysfunction resulting from left-sided pulmonary atelectasis caused by hemothorax.

Considering the prevalence and risk of PAVM in patients with HHT, the current expert consensus recommends routine screening for PAVM in patients with HHT.[1,2] Noninvasive screening using right heart acoustic imaging is initially recommended,[8] with the presence of a left heart shadow after 3–4 or more cardiac cycles of right heart shadowing indicative of pulmonary arteriovenous fistula. CT can be performed for confirmation and staging for PAVM to guide subsequent treatment and post-treatment follow-up. Besides, enhanced MR angiography can also be used for diagnosis and staging, particularly suitable for pregnant women and children due to the absence of ionizing radiation.[9]

The current consensus is that PAVMs with feeding arteries measuring 3 mm in diameter or larger should be treated, regardless of the clinically symptomatic nature of the fistula.[2] Interventional embolization has long been considered the preferred treatment option, recommended for all adults with PAVM and symptomatic children. Although spring coils are frequently employed for feeding arteries less than 5 mm in diameter, the risk of spring coil dislodgement is significantly higher for arteries exceeding 5 mm in diameter, leading not only to recanalization but also to a significantly higher risk of ectopic embolism. Therefore, blockers remain the optimal treatment option for larger arteriovenous fistulas. Indeed, these tools have demonstrated high effectiveness and safety in a large number of studies. Nonetheless, it is worth acknowledging that these studies were retrospective in nature and prone to biases. There is a lack of high-quality randomized controlled trial evidence to support the treatment options.[10]

Patients with a ruptured PAVM and active hemorrhage have a higher mortality rate during surgical resection due to hemorrhagic anemia, acute respiratory failure, and hemodynamic instability. In addition, the time required to prepare for thoracoscopic surgery is longer than embolization therapy, and the risk of ongoing bleeding or re-rupture of the PAVM is present. In contrast, embolization therapy is more convenient and enables timely hemostasis.[11] Following interventional embolization and occlusion for a ruptured PAVM, the hemothorax should be effectively managed. Delayed management can affect lung tissue recovery and infection. Closed chest drainage is the recommended initial approach for the management of hemothorax, given its convenience and safety. For patients experiencing heavy bleeding or prolonged disease, fibrin deposition in the pleural cavity leads to compartmentalization and the formation of encapsulated pleural effusions. For such patients, drainage is often ineffective. Surgical removal of the accumulated blood and confirmation of the presence of active bleeding is necessary for patients with hemothorax that cannot be completely resolved by drainage. Studies have documented that thoracoscopic-assisted treatment is safer and more practical than traditional open methods, yielding favorable treatment outcomes and low subsequent recurrence rates, thereby enhancing patient survival. Herein, after being subjected to interventional embolization for 20 days, the patient underwent surgery to remove the accumulated blood in the chest cavity. Intraoperatively, active bleeding was observed at the embolization site. Indeed, achieving complete occlusion using a blocker in such a large arteriovenous fistula proved difficult. Thus, a left lower lung lobectomy was executed to achieve hemostasis.

In the current report, the management of this patient with PAMV rupture and comorbid hemothorax generally involves emergency surgery, which has been hypothesized to significantly mitigate the risk of death and recurrence. However, our patient was actively bleeding, and direct surgical treatment may pose additional risks. Therefore, the “staged” approach was adopted to initially stop bleeding, followed by a second surgical intervention to address pulmonary dilation and hemothorax. However, the likelihood of ruptured PAVM leading to hemothorax is low, and the occurrence of ruptured giant arteriovenous fistula combined with such a large hemothorax is even rarer.[12] Although this strategy has achieved excellent results herein, its feasibility as the

gold standard treatment for patients with ruptured PAVM and a large hemothorax warrants further investigation. Nevertheless, this approach offers a new perspective, implying that a "STAGED" approach may mitigate surgical risks and concomitantly improve the clinical outcomes of patients.

AUTHOR CONTRIBUTIONS

All authors contributed significantly to this work. Xiangkai Fu, Zixiao Wang, and Te Li directly participated in the care of the patient. Xianzhi Li, Yinghan Feng, and Guoying Zhang performed background research and chart audits related to the case presentation. Shudong Wang served as a HHT content expert Xiangkai Fu drafted and revised the manuscript.

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The authors have nothing to report.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ETHICS STATEMENT

We obtain informed consent from the patient reported in this case. All patient identifiers have been removed from case details to limit any risk to patient privacy.

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REFERENCES

1. Faughnan ME, Palda VA, Garcia-Tsao G, Geisthoff UW, McDonald J, Proctor DD, Spears J, Brown DH, Buscarini E, Chesnutt MS, Cottin V, Ganguly A, Gossage JR, Guttmacher AE, Hyland RH, Kennedy SJ, Korzenik J, Mager JJ, Ozanne AP, Piccirillo JF, Picus D, Plauchu H, Porteous MEM, Pyeritz RE, Ross DA, Sabba C, Swanson K, Terry P, Wallace MC, Westermann CJJ, White RI, Young LH, Zarrabeitia R. International guidelines for the diagnosis and management of hereditary haemorrhagic telangiectasia. J Med Genet. 2011;48(2):73–87.
2. Faughnan ME, Mager JJ, Hetts SW, Palda VA, Lang-Robertson K, Buscarini E, Deslandres E, Kasthuri RS, Lausman A, Poetker D, Ratjen F, Chesnutt MS, Clancy M, Whitehead KJ, Al-Samkari H, Chakinala M, Conrad M, Cortes D, Crocione C, Darling J, de Gussem E, Derksen C, Dupuis-Girod S, Foy P, Geisthoff U, Gossage JR, Hammill A, Heimdal K, Henderson K, Iyer VN, Kjeldsen AD, Komiyama M, Korenblatt K, McDonald J, McMahon J, McWilliams J, Meek ME, Mei-Zahav M, Olitsky S, Palmer S, Pantalone R, Piccirillo JF, Plahn B, Porteous MEM, Post MC, Radovanovic I, Rochon PJ, Rodriguez-Lopez J, Sabba C, Serra M, Shovlin C, Sprecher D, White AJ, Winship I, Zarrabeitia R. Second international guidelines for the diagnosis and management of hereditary hemorrhagic telangiectasia. Ann Intern Med. 2020;173(12):989–1001.
3. Shovlin CL, Guttmacher AE, Buscarini E, Faughnan ME, Hyland RH, Westermann CJJ, Kjeldsen AD, Plauchu H. Diagnostic criteria for hereditary hemorrhagic telangiectasia (Rendu-Osler-Weber syndrome). Am J Med Genet. 2000;91(1):66–7.
4. Anderson E, Sharma L, Alsafi A, Shovlin CL. Pulmonary arteriovenous malformations may be the only clinical criterion present in genetically confirmed hereditary haemorrhagic telangiectasia. Thorax. 2022;77(6):628–30.
5. Govani FS, Shovlin CL. Hereditary haemorrhagic telangiectasia: a clinical and scientific review. Eur J Human Genet. 2009;17(7):860–71.
6. Gallione CJ, Richards JA, Letteboer TGW, Rushlow D, Prigoda NL, Leedom TP, Ganguly A, Castells A, Ploos van Amstel JK, Westermann CJJ, Pyeritz RE, Marchuk DA. SMAD4 mutations found in unselected HHT patients. J Med Genet. 2006;43(10):793–7.
7. Shovlin C, Sodhi V, McCarthy A, Lasjaunias P, Jackson J, Sheppard M. Estimates of maternal risks of pregnancy for women with hereditary haemorrhagic telangiectasia (Osler-Weber-Rendu syndrome): suggested approach for obstetric services. BJOG. 2008;115(9):1108–15.
8. Gossage JR. Role of contrast echocardiography in screening for pulmonary arteriovenous malformation in patients with hereditary hemorrhagic telangiectasia. Chest. 2010;138(4):769–71.
9. Schneider G, Uder M, Koehler M, Kirchin MA, Massmann A, Buecker A, Geisthoff U. MR angiography for detection of pulmonary arteriovenous malformations in patients with hereditary hemorrhagic telangiectasia. Am J Roentgenol. 2008;190(4):892–901.
10. Hsu CC, Kwan GN, Evans-Barns H, et al. Embolisation for pulmonary arteriovenous malformation. Cochrane Database Syst Rev. 2018;1(1):Cd008017.
11. Nagano M, Ichinose J, Sasabuchi Y, Nakajima J, Yasunaga H. Surgery versus percutaneous transcatheter embolization for pulmonary arteriovenous malformation: analysis of a national inpatient database in Japan. J Thorac Cardiovasc Surg. 2017;154(3):1137–43.
12. Azimi-Ghomi O, Ramirez M, Brummund D, Gibber M, Mawad MR. Traumatic pulmonary arteriovenous malformation presenting as spontaneous hemothorax. Cureus. 2021;13(6):e16072.

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