

Endovascular Coil Embolization of Multiple Pulmonary Arteriovenous Malformations in Osler-Weber-Rendu Disease: A Challenging Pursuit

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ABSTRACT

Pulmonary arteriovenous malformations (PAVMs) are a rare disorder with an incidence of 2-3/1,000,000 population. Approximately 70% of cases are associated with Osler-Weber-Rendu Disease. This intrapulmonary malformation causes hypoxemia and dyspnea largely attributed to the right to left shunting.

We present a case of a 25-year-old male who was admitted for fever and headaches with chronic history of epistaxis, hemoptysis, cyanosis and clubbing. Central cyanosis and clubbing were evident with hypoxemia of 65%. Heart sounds and peripheral pulses were normal. There was no systolic bruit noted in the lung bases. Multiple telangiectasias were seen in the truncal area and abdomen. Chest x-ray revealed multi-chambered cardiomegaly with no opacifications. CBC showed erythrocytosis with hematocrits of 0.68-0.78. Transthoracic echocardiography showed intact interatrial and interventricular septum, with contrast study suggestive of intrapulmonary shunting. CT angiography revealed PAVMs in bilateral lung fields. Pulmonary angiography demonstrated diffuse PAVMs in the left lung with 3 large PAVMs with multiple feeders > 7mm and smaller PAVMs in the Right lower lobe. The diagnosis was Multiple Pulmonary Arteriovenous Malformation, Osler-Weber-Rendu Disease, Brain Abscess Left Temporoparietal area. Craniotomy with brain abscess evacuation was done. Left pneumonectomy or Right lobectomy was considered but was deemed unacceptable due to high morbidity and mortality. Endovascular coil embolization was done on the 3 large fistulas on the Left lobe. Post procedure, his arterial oxygenation

improved to 96%. He has no recurrence of hemoptysis, no headaches and with less episodes of shortness of breath 2 months on follow-up. Diagnosing the complex diffuse intrapulmonary malformations requires a high index of suspicion among patients with chronic cyanosis, chronic history of bleeding, and brain abscess. Treatment of this condition and its associated complications remain a big challenge and should be highly individualized.

Key Words: endovascular coil embolization, multiple pulmonary arteriovenous malformations, Osler-Weber-Rendu disease, Hereditary Hemorrhagic Telangiectasia

Introduction

Pulmonary arteriovenous malformation (PAVM) is a rare disorder with an incidence of 2-3/1,000,000 population. Approximately 70% of cases are associated with Osler-Weber-Rendu Disease or Hereditary Hemorrhagic Telangiectasia. Diagnosing and managing this condition posed a considerable challenge in a patient who came in for recurrent headaches and fever. This paper focused on our clinical approach to how this intrapulmonary malformation was diagnosed and managed.

Case Presentation

A 25-year-old Filipino male was initially admitted by Neurology service for recurrent headaches and pallor. He was referred to cardiology service for clearance prior to craniotomy for brain abscess. He had chronic history of epistaxis, hemoptysis, cyanosis and clubbing since he was 9-years old with no prior consult. He had family history of early uninvestigated cardiac deaths among his siblings. His birth and developmental history were unremarkable.

The patient was thin, pale and cyanotic. His Oxygen saturation at room air was 65%. There was central cyanosis and clubbing. He was normotensive, mildly tachycardic and febrile. Cardiac exam showed no chest deformities, adynamic precordium, apex was not displaced, with no noted murmurs. His peripheral pulses were normal. Auscultation of the chest revealed bronchovesicular breath sounds with no systolic bruit noted in the lung bases. Multiple telangiectasias were found in the abdomen, in the shoulder, and in the left arm (Figure 1).

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Figure 1. Multiple telangiectasias in the abdomen and shoulder.

His ECG revealed sinus rhythm with normal axis and left ventricular hypertrophy. While his Chest x-ray revealed multi-chambered cardiomegaly with no noted infiltrate, mass and abnormal opacifications (Figure 2). His CBC showed erythrocytosis with hematocrits of 0.68-78. His baseline hematocrit was 0.68. The arterial blood gas at room air revealed hypoxemia of PO₂ 40.8 with saturation of 63%. His pulmonary function test was normal. Brain CT scan showed brain abscess in the left temporoparietal lobe.

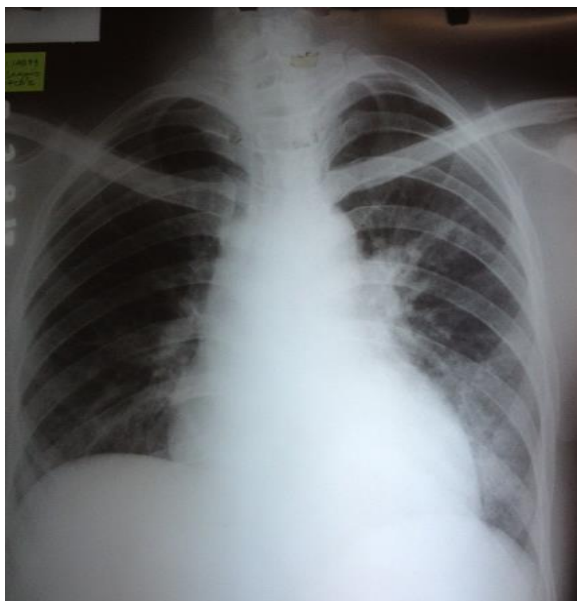


Figure 2. Chest x-ray showing multi-chambered cardiomegaly with no abnormal opacities.

Transthoracic Echocardiogram (TTE) revealed eccentric left ventricular hypertrophy with preserved systolic function, dilated Left atrium with LAVI of 38. Right atrium and right ventricles dimensions were normal. The interatrial and interventricular septums were intact. No stenotic or regurgitation lesion was noted. The pulmonary artery

pressure was normal. A suspicious flow was noted in the aortopulmonary area during systole with a consideration for a major aortopulmonary collateral versus venous arterial malformation (Figure 3). Use of Bubble contrast showed a delayed appearance of contrast in the Left atrium after 6 cardiac cycles which suggested an intrapulmonary shunt.

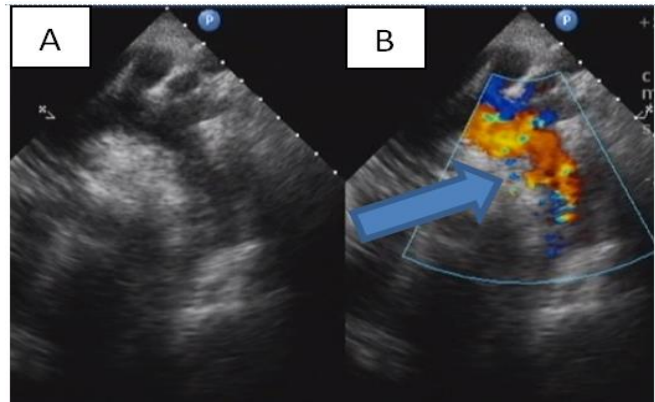


Figure 3. (A) Suprasternal view of the patient's TTE; (B) On application of color revealed a suspicious flow noted in the aortopulmonary area. (Blue arrow)

To document the presence of arteriovenous malformation, a chest CT angiography was done. The study revealed 3 areas of dilated and tortuous tangle of pulmonary arteries and veins were noted (Figure 4a) in the left apicoposterior upper lobe, Left superior segment of lower lobe, Left posterobasal lower lobe and Superior segment of Right lower lobe (Figure 4b).



Figure 4a. Coronal cut of Chest CT with contrast which showed 3 large areas of PAVMs



Figure 4b. Cross sectional view revealed a PAVM in the left posterior basal lobe with multiple feeders.

Pulmonary angiography was done to map the vasculature and locate the feeder arteries. Using Digital Subtotal Angiography (DSA) diffuse PAVMs were found in the left lung field (Figure 5a). Selective catheterization of the left Pulmonary artery showed 3 large PAVMs with feeders as large as 7 mm were identified (Figure 5b,c). Selective injection of contrast media to the right pulmonary artery demonstrated smaller PAVMs and fistulas. Resting hemodynamics showed elevated RV systolic pressures with normal RA, PA and LV pressures. Oximetry run was attempted but his saturations were undetectable.



Figure 5a. DSA of selective catheterization of Left Pulmonary artery which showed diffuse PAVMs in the left lung.

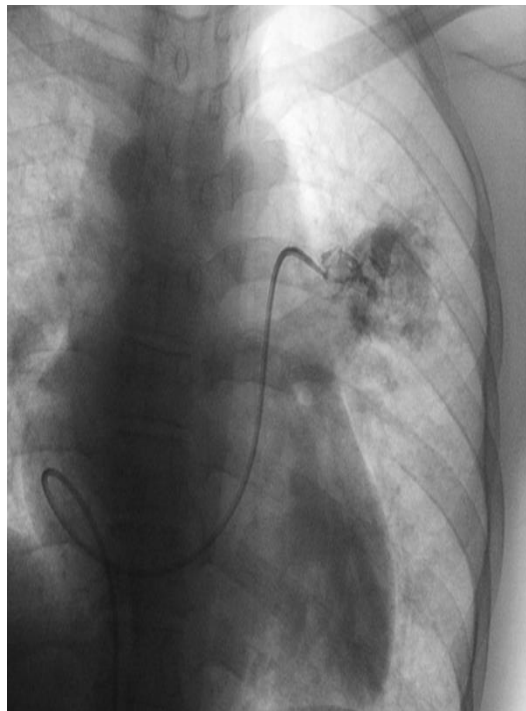


Figure 5b. Selective catheterization of a PAVM.

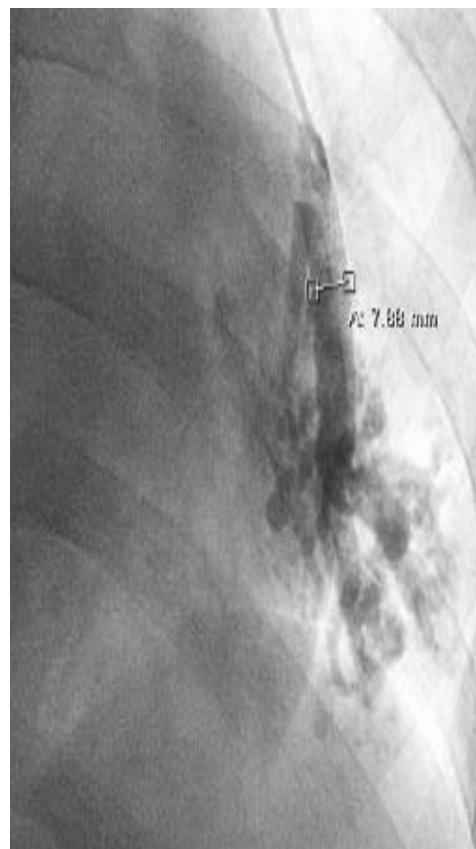


Figure 5c. Feeder artery measuring 7.8 mm

Because the lesions were multiple and widespread, conservative resection was not applicable. A combined staged approach was initially considered. Staged Embolization of the right PAVM, followed by Left pneumonectomy was proposed. Although he is a viable candidate for surgery with an acceptable predicted postoperative lung function, Surgery was not an option accepted by the relatives due to its high morbidity and high mortality.

A conservative approach of transcatheter embolization of the 3 large PAVMs in the left lung with the intention of reduction of the right to left shunt, improve oxygenation and lessen risk of paradoxical embolization and stroke was finally attempted. Pre-procedural arterial blood gas showed hypoxemia of pO₂ of 45, saturations of 63% and baseline 6 min walk test was 250 meters.

A total of 2 Gianturco steel coils (Figure 6a) in the left upper PAVM, 2 coils in the left mid PAVM and 2 coils in the left lower basal PAVM were deployed. (Figure 6b).



Figure 6a. Gianturco steel coils.

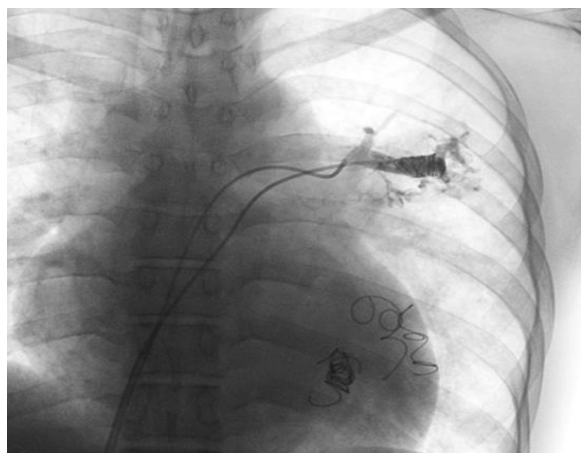


Figure 6b. Gianturco steel coils deployed at 3 large PAVMs.

Post-operatively, the patient's oxygen saturation immediately went up 98%. He developed hemoptysis and presented with mild transient ischemic attacks day 2 post-op which spontaneously resolved and did not recur. He was

discharged asymptomatic with oxygen saturation at room air of 86%.

After 2 months, the patient came back with no recurrence of bleeding episodes and transient ischemic attacks. His oxygen saturation at room air was 80-86%. His 6-minute walk test was 450 meters. A repeat pulmonary angiography for surveillance and possibly embolization of other PAVMs after several months was planned.

Discussion

Pulmonary arteriovenous malformations (PAVMs) are direct abnormal communications between pulmonary arteries and pulmonary veins. It is a rare disorder with an incidence of 2-3/1,000,000 population. More than 80% of PAVMs are congenital.¹ Approximately 70% of cases are associated with Osler-Weber-Rendu Disease or Hereditary Hemorrhagic Telangiectasia.²

Osler-Weber-Rendu Disease is an autosomal dominant disorder with widespread cutaneous, mucosal and visceral telangiectases.¹ Spontaneous recurrent epistaxis, multiple telangiectasias in typical locations, proven visceral AVM (lung, liver, brain, and spine) and a positive first degree family member forms the Curacao criteria for diagnosis of the condition. Our patient met 3 out of the 4 criteria.

The classic triad of pulmonary arteriovenous malformations (dyspnoea, cyanosis and clubbing) is present in our patient but is usually present in only 10% of the cases.³ Usual physical examination findings are superficial telangiectasias in the lower lip, nose, mouth, chest and upper extremities,³ and a systolic bruit in the lung bases which increases with inspiration and forced inspiration with a closed glottis after full expiration (Muller maneuver). Complications, including erythrocytosis, hyperviscosity syndromes, cerebral abscess, stroke or transient ischemic attacks due to paradoxical embolization, may occur in 33% of cases. All of these were present in our patient.⁴

For patients suspected of PAVMs and/or Osler-Weber-Rendu Disease, a chest radiograph may show rounded multilobular opacities and a peripheral arterial blood gas may show <92% or with >4% change on moving from supine to upright position which are suggestive findings.² Chest CT with contrast will document the presence of PAVMs with specificity of 100%. Contrast echocardiography is recommended to evaluate for any concomitant intracardiac abnormality and shunting. Contrast pulmonary angiography remains the gold standard to confirm presence of PAVMs and to define the vascular architecture of pulmonary vasculature which is necessary before therapeutic embolization or surgical resection.^{1,5}

Treatment of a PAVM is indicated in patients with progressive enlargement of the lesions, paradoxical embolization, persistent symptomatic hypoxemia and with identified feeding vessels of 3 mm or larger. Surgery using lung conserving resection with segmentectomy or local

excision is the general recommendation for PAVMs but is not applicable to this patient with diffuse bilateral PAVMs. For multiple bilateral PAVMs there is no standardized treatment. At present there is no guideline on how to assess suitability of these patients for surgery. The American College of Chest Physicians 2007 Guideline on Lung Resection for Lung Cancer was applied to our patient. Baseline FEV of >1.5 L, >2L for pneumonectomy and DLCO of >80% confers average risk. A Predicted Postoperative (PPO) lung function can be computed using the formula:

$$\frac{\text{Pre-operative FEV (1- number of functional segments to be removed)}}{\text{Total number of functional lung segments}}$$

0.8 L PPO FEV is the lower limit to allow patients to undergo surgical resection.⁷ Removing approximately 9 segments in doing a Left pneumonectomy on this patient will confer 9% operative mortality, 53-60% risk for long term disability and recurrence rate of 12%.⁷ These statistics may only apply if the remaining lung segments are normally functioning and free of disease, which is not the case for our patient.

Embolization is a suitable alternative especially for multiple PAVMs. It involves the localization of the PAVMs followed by selective catheterization of the feeding artery. An amplatzer device, steel coil or vascular plug is advanced through the catheter and placed distal to any branch of the vessel. Steel coil embolization is preferred due to its association with low morbidity and good outcome in terms of right to left shunt reduction. Treatment success rate in high volume centers is 75% with delayed recanalization and recurrence of 12-17%.⁸

To attempt a complete embolization of this patient's diffuse and widespread PAVMs is obviously impossible. Based on a study of Gupta et al on 66 patients with Multiple PAVMs, incomplete embolization with remaining feeders > 3 mm can still impart significant reduction of 19% in mean Right to left shunting, with increase of 8% in arterial saturation.⁹ Although no apparent change in maximum workload should be expected, this patient post embolization presented with significant improvement in functional capacity.

Embolization carries inherent properties of delayed recanalization and recurrence. As recruitment of new arteriovenous beds post operatively remains a concern for this patient, repeat PA for surveillance ± embolization is part of the long-term plan. Regular follow-up should also include pulse oximetry checks, echocardiography and chest radiography.

A combined surgery and staged embolization¹⁰ and bilateral lung transplantation¹¹ are other approaches that have been attempted on multiple bilateral PAVMs. These have showed improvement on oxygenation and functional capacity, but these cases had no long term follow-up.

To date there is no long- term survival studies concerning PAVMs and HHT. If left untreated, the approximate growth rate of these malformations is about 5-10 mm every 5-15 year. The morbidity is 50% in untreated versus 3% in patients who were treated. PAVM related mortality is 1-12%.¹²

Conclusion

Presented herein is a rare case of multiple pulmonary arteriovenous malformations with bilateral lung involvement in a patient with Osler-Weber-Rendu disease. The incidence of this condition in the adult population is unknown and may be underestimated in our local setting. A high index of suspicion should be upheld in patients with chronic cyanosis, chronic history of bleeding, and brain abscess. Management of these rare diffuse intrapulmonary malformations and its associated complications remains a challenge and should be highly individualized.

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