 doi:10.20944/preprints202011.0475.v1

Case Report

Pulmonary arteriovenous malformation as a cause of exercise intolerance in children: A case report

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Abstract: Pulmonary arteriovenous malformation (PAVMs) in children are rare lesions characterized by abnormal low resistance vascular structures connecting a pulmonary artery to a pulmonary vein, resulting in an intrapulmonary right-to-left shunt. The insidious onset and variable signs and symptoms make diagnosis difficult, especially in children. PAVMs can be single or multiple, congenital or acquired, and up to 47-80% of cases are associated with hereditary hemorrhagic telangiectasia (HHT).We present the case of a 12-year-old female teenager referred to our center for epistaxis, headache, fatigue and weakness, with evidence of mild oxygen desaturation. Bubble test showed a right-to-left shunt and pulmonary angio-CT confirmed the diagnosis. Percutaneous selective embolization was performed with full recovery of normal arterial oxygen saturation. When differentiating between mild oxygen desaturation and exercise intolerance in children and adolescents, physicians should be aware of the possibility of PAVMs as a cause.

Keywords: pulmonary arteriovenous malformation, exercise intolerance, oxygen desaturation

1. Case Report

The case was a 12-year-old female who was born via Cesarean section for breech presentation with a birth weight of 2,900 g, as the first child of non-consanguineous parents. Her neonatal period was uneventful and her parents were seemingly healthy. At the age of 11 years, she experienced a fleeting episode of fever. A chest X ray was performed which showed an increased density in the left upper lobe. Antibiotic therapy was prescribed until fever resolution. The patient suffered later from occasional headaches, nose-bleeding, fatigue and exercise intolerance. Mild oxygen desaturation (spO2 94%) was noted by her pediatrician and she was referred to our hospital. The family history highlighted on the paternal line: a relative in collateral line of III° affected by pulmonary arteriovenous malformation (PAVM); father with epistaxis and muco-cutaneous telangiectasias; three relatives in collateral line of III ° affected by epistaxis and headache and a collateral relative of IV ° with telangiectasias on the lower lip and fingertips; with little indication on the maternal line

Her body weight was 48 kg and her height 161 cm (body mass index 27.5). On physical examination, a continuous 2/6 murmur with systolic reinforcement was best noted at the sub-clavicular border.

There was no telangiectasias, clubbing, cyanosis or enlargement of the liver or edema in the lower legs, and her extremities were not cold. Pulse oximetry showed oxygen saturation of 94% in room air. Laboratory tests showed a slight increase in red blood cells (RBC 5,580,000 u / L), Hb (16.4 g / dl) and hematocrit (46.8%), with normal mean corpuscular volume (84.2 fl) .Electrocardiogram showed *normal* sinus rhythm with no ST-segment changes. Echocardiography showed normal left and right atria and ventricular size and function. Based on clinical history and previous x ray image, a bubble test was performed with shaken saline solution, infused in the brachial vein, showing

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sudden moderate filling of the left atrium, with the appearance of micro bubbles (MES) a few cycles after their display in the right atrium (Fig. 1).

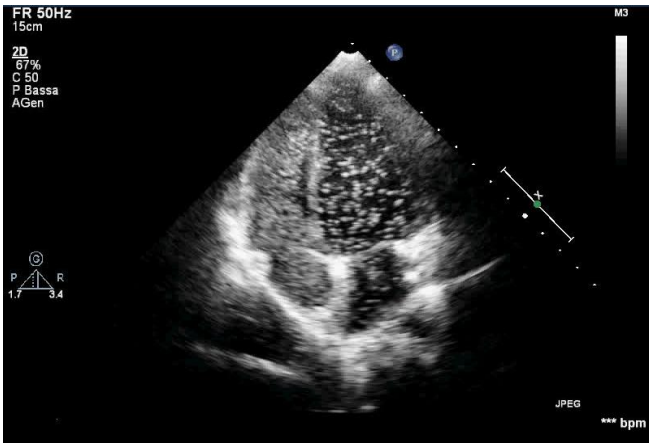

Figure 1. : Bubble test on echocardiography showing sudden moderate filling of the left atrium, with the appearance of micro bubbles (MES) a few cycles after their display in the right atrium.

Pulmonary angio-CT scan showed voluminous PAVM in the apical and anterior segment of the left upper lobe, supplied by the apical segmental artery and by its sub-segmental branch draining in the left upper pulmonary vein, without interposed nidus. Maximum transverse diameter (TD) of the main afferent branch was 7.7 mm and 2 mm for the sub-segmental branch. Further millimetric PAVM in the posterior basal segment of the left lower lobe was found (Fig. 2).

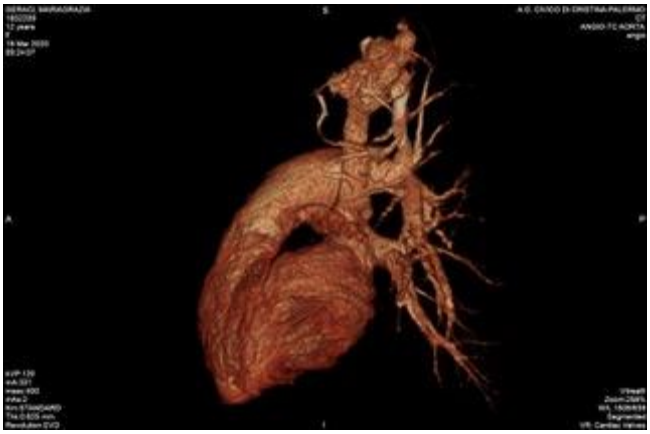

Figure 2. : Contrast enhanced computed tomography image, showing voluminous PAVM in the apical and anterior segment of the left upper lobe, supplied by the apical segmental artery and by its sub-segmental branch draining in the left upper pulmonary vein, without interposed nidus.

The patient underwent percutaneous selective PAVM closure using a 12 mm *amplatzer occlusive system* for the apical segmental branch and coil occlusion for the small subsegmental branch (Fig.3).

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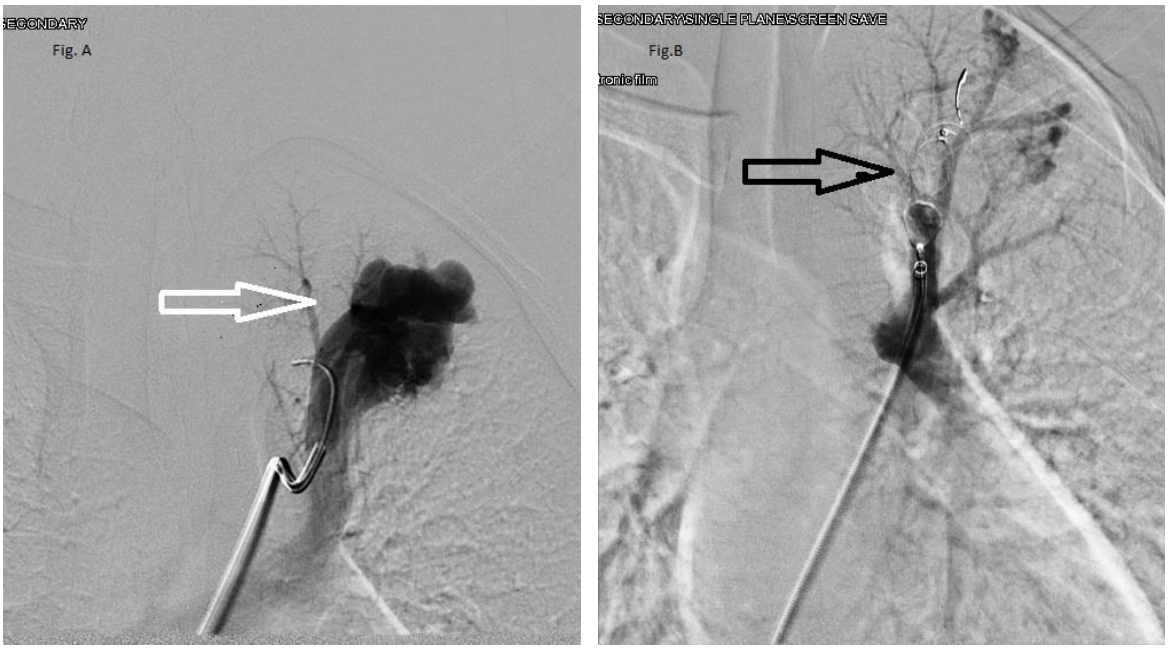

Figure 3. : Pre- and post-device closure angiographic still frames of pulmonary arteriovenous malformations in the apical and anterior segment of the left upper lobe. Fig. A shows preintervention angiography of the feeding arterial and draining venous vessels in the apical and anterior segment of the left upper lobe (white arrow) . Fig. B shows post-12 mm *amplatzer occlusive system* device closure of the apical segmental branch with no residual shunting (black arrow).

At the one year examination after the procedure, she was in good physical condition with normal oxygen saturation (spO2 98% in room air) without fatigue and exercise intolerance.

2. Discussion

Pulmonary arteriovenous malformation (PAVMs) in children are rare lesions characterized by abnormally low resistance vascular structures connecting a *pulmonary* artery to a *pulmonary* vein, bypassing the normal *pulmonary* capillary bed and resulting in an intrapulmonary right-to-left shunt.[3] It is the most common congenital pulmonary vascular anomaly, with an incidence of 1: 2600, and a female/male ratio of 1.5-1.8.[1] PAVMs can be single or multiple, congenital or acquired, and up to 47-80% of cases are associated with hereditary hemorrhagic telangiectasia (HHT), also known as Rendu-Osler-Weber disease.[4] The insidious onset and variable *signs* and *symptoms such as dyspnoea, hemoptysis, neurological symptoms and cyanosis represent only 15% of cases,* making *diagnosis difficult,* especially in children.[5] The patient described above represents a rare case of PAVM in the pediatric population. From an embryological and anatomical point of view, it belongs to the second group of the Anabtawi classification.[3-6] As in most cases described in the literature, even our case had mild symptoms.[1] It is well known that the share of the right-left shunt determines the clinical picture: if it is more than 20% of the cardiac systemic output, the resulting hypoxemia will determine varying degrees of dyspnoea, cyanosis, digital hippocratism and compensatory polycythemia; if it is less than 20%, the symptoms are blurred or absent, as in the case of our patient.[1-3] Neurological complications represented by headache, ischemic stroke and brain abscess occur in 15-50% of cases and are related to paradoxical embolism through PAVM. Hemorrhagic complications due to AV rupture causing hemoptysis or hemothorax and are rare.[3-7] None of these complications have been observed in our patient. At first, chest x-ray was suggestive of pneumonia or neoplasia, that entered into a differential diagnosis with PAVM.[4-8] In suspected vascular extracardiac disorders resulting in right-to left shunt, a bubble test could be particularly useful, and desirable for its ease of execution, repeatability and absence of complications. Pulmonary angio-CT, as widely described in the literature, is the diagnostic gold standard that confirmed the diagnosis, providing accurate anatomical data of the malformation. Most PAVM are located in the lower left lobe;[3] in our case, the AVM was located

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instead in the upper left lobe. When a PAVM is diagnosed, it's important to exclude Rendu-Oler-Weber (ROW) disease, burdened with a higher rate of complications and poorer prognosis,[3-4] confirmed in the presence of at least three criteria among the following: epistaxis, multiple skin-mucosal telangiectasias, visceral lesions, cerebral and spinal AVM, pulmonary AVM, gastro-enteric telangiectasias, family history (relative of I ° affected by HHT according to these criteria).[9-10] While epistaxis, the most common clinical manifestation in children, shows a childhood-onset, telangiectasias can be found in puberty or adulthood or be completely absent.[3,10] In the presence of incomplete symptomatology, the family history plays a central role for the diagnosis and the case described is an example. The multi-generational family history, at first considered irrelevant, in a subsequent examination highlighted the presence of two certain cases of HHT in the father and in a relative of III° and several cases of probable diagnosis in the paternal line. Nowadays, selective percutaneous occlusion represents the gold standard treatment of PAVMs, and can be carried out in symptomatic or asymptomatic cases with an afferent arteriole diameter more than 3 mm with good results in terms of safety and efficacy.[11-12]

In conclusion, when differentiating mild oxygen desaturation and exercise intolerance in children and adolescents, physicians should be aware of the possibility of PAVMs as a cause. Percutaneous occlusion is the treatment of choice of PAVMs and can be considered a safe and effective procedure in the paediatric population.

Author Contributions:

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Collected the data and performed bubble test echocardiography

Mario Giuseppe Vallone , Francesca Finazzo

Collected the data and performed TC scan and PAVM closure

Vincenzo Antona

Collected the data and performed genetic evaluation

Veronica Notarbartolo , Pierluigi Morreale , Giancarlo Allegro

Wrote the paper

Funding: This research received no external funding.

Acknowledgments: None. No funding to declare.

Conflicts of Interest: The authors declare no conflict of interest.

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