

# Patent foramen ovale and paradoxical coronary artery embolism: rare event with great clinical relevance

Claudia Morabito<sup>a</sup>, Michele Scarano<sup>b</sup>, Eugenio Genovesi<sup>b</sup>, Vittoria Vaccaro<sup>a</sup>, Giulia Laterra<sup>a</sup>, Pasquale Crea<sup>a</sup>, Giuseppe Dattilo<sup>a</sup>, Matteo Casale<sup>a</sup>

<sup>a</sup> Department of Clinical and Experimental Medicine, University of Messina, Italy

<sup>b</sup> Cardiology Unit, Emergency Department, Hospital "Madonna del Soccorso", San Benedetto del Tronto, Italy

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## SOUHRN

Otevřené foramen ovale (PFO) je nejčastější strukturální srdeční anomálií spojenou s paradoxní embolií. Onemocnění zvyšující tlak v dutinách pravého srdce, např. plicní embolie, mohou způsobit otevření PFO a zvýšit riziko průchodu trombů ze žilního do tepenného oběhu. Paradoxní embolie je vzácnou příhodou se závažnou prognózou. Tato kazuistika popisuje případ 77leté ženy, která byla dopravena na oddělení akutního příjmu pro dyspnoe, zmatenost a bolest na hrudi s kardiogenním šokem. EKG prokázalo významnou elevaci úseku ST ve vysokých laterálních svodech. Jak EKG, tak klinické vyšetření naznačovalo masivní plicní embolii s následnou paradoxní embolií přes PFO, což vedlo k akutnímu infarktu myokardu. Okamžitě byla zahájena trombolytická terapie; infuze komplikovala bezpulsová elektrická aktivita vedoucí k úmrtí přes odpovídající rozšířenou podporu životních funkcí. Kazuistika upozorňuje na význam rozpoznání a pečlivého zhodnocení známek a příznaků paradoxní a periferní embolie na podkladě plicní embolie u pacientů s PFO.

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## ABSTRACT

Patent foramen ovale (PFO) is the most common structural cardiac anomaly associated with paradoxical embolism. Conditions increasing right heart chambers pressure, such as pulmonary embolism, can lead to its opening with increased risk of passage of thrombi from the venous to arterial circulation. Paradoxical embolism is a rare event with a possible severe prognosis. This case report is focused on a 77-year-old woman who was transported to the Emergency Department because of dyspnea, confusion, and chest pain with cardiogenic shock. The ECG showed a significant ST-T elevation in the high lateral leads. Both echocardiographic and clinical data suggested massive pulmonary embolism and consequent paradoxical embolism through a PFO, causing acute myocardial infarction. Immediate fibrinolytic therapy was performed; infusion was complicated by pulseless electrical activity leading to death despite adequate advanced life support. The report discusses the importance of carefully evaluating and recognizing the signs and symptoms of paradoxical coronary and peripheral embolism, secondary to pulmonary embolism, in patients with PFO.

### Keywords:

Coronary artery disease

Paradoxical coronary artery embolism

Patent foramen ovale

ST elevation myocardial infarction

**Address:** Prof. Giuseppe Dattilo, Department of Clinical and Experimental Medicine, Section of Cardiology, AOU "Policlinico G. Martino", Via Consolare Valeria n.1, 98125 Messina, Italy, e-mail: giu.dattilo@libero.it

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## Introduction

Patent foramen ovale (PFO) is defined as the persistence of a patency between the septum primum and the septum secundum located in the oval pit. The PFO is the path needed for the physiological blood flow from right atrium to atrium during prenatal life. After the delivery the increase of left atrial pressures of the newborn, consequent to the activation of pulmonary circulation, results in a functional closure of this patency with later anatomical closure. Some studies showed a persistent patency of foramen ovale in 25–35% of the adult population.<sup>1–3</sup> It is therefore a very common congenital abnormality in the general population, in most cases asymptomatic. Sometimes the closure is on a functional basis with a valve mechanism leading to its opening only with increase in right heart chambers pressure. Therefore pathological conditions increasing right heart chambers pressure, such as pulmonary hypertension, pulmonary embolism and even Valsalva maneuver, may facilitate its opening leading to paradoxical embolism because of passage of thrombi or emboli from the venous to the arterial circulation through a right-left shunt, as described by Cohnheim.<sup>4</sup> Several cases of transient thrombi through a PFO and subsequent peripheral embolization have been reported in literature.<sup>5–12</sup>

## Case presentation

A 77-year-old woman was transported to Emergency Department because of cardiogenic shock with dyspnea, retrosternal chest pain for about an hour and confusion. She had a history of psoriasis, arterial hypertension, and mild hypercholesterolemia with sporadic episodes of atypical chest pain. A previous stress echocardiography by dipyridamole of few months before was normal.<sup>13,14</sup> In the Emergency Department the patient was cold and

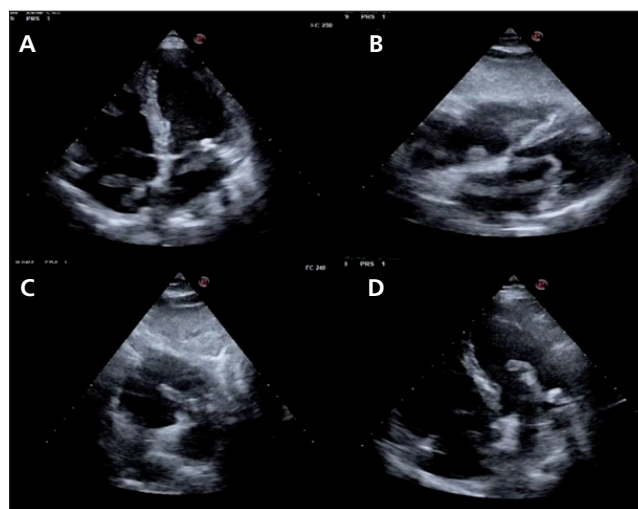


Fig. 2 – (A) Four-chamber apical view with evidence of thrombotic formation in the right atrium attached to the SIA and in the left atrium. (B) Four-chamber subcostal view: thrombotic formation prolapsing in the left ventricle through the SIA and through the mitral valve. (C) Subcostal view: Probable passage of thrombotic formation through SIA. (D) Four-chamber apical view: thrombotic formation prolapsing in the left ventricle.

sweaty with clinical signs of cardiogenic shock (blood pressure [BP] 70/40 mmHg, heart rate [HR] 110/min). The ECG showed a significant ST-T elevation in the high lateral leads (Fig. 1). An echocardiogram showed several echogenic formations moving from the right to the left atrium in some cases prolapsing in the respective ventricles during diastole with obvious passage through the interatrial septum (Fig. 2). On the aortic valve, a similar formation was attached to the non-coronary cusp (Fig. 3A).<sup>5,6</sup> Ventricles were both dilated and hypokinetic (ejection fraction [EF] 30%, tricuspid annular plane systolic excursion [TAPSE] 11 mm), with overt signs of pressure overload in right chambers (D-shape left ventricle, McConnell's sign) and

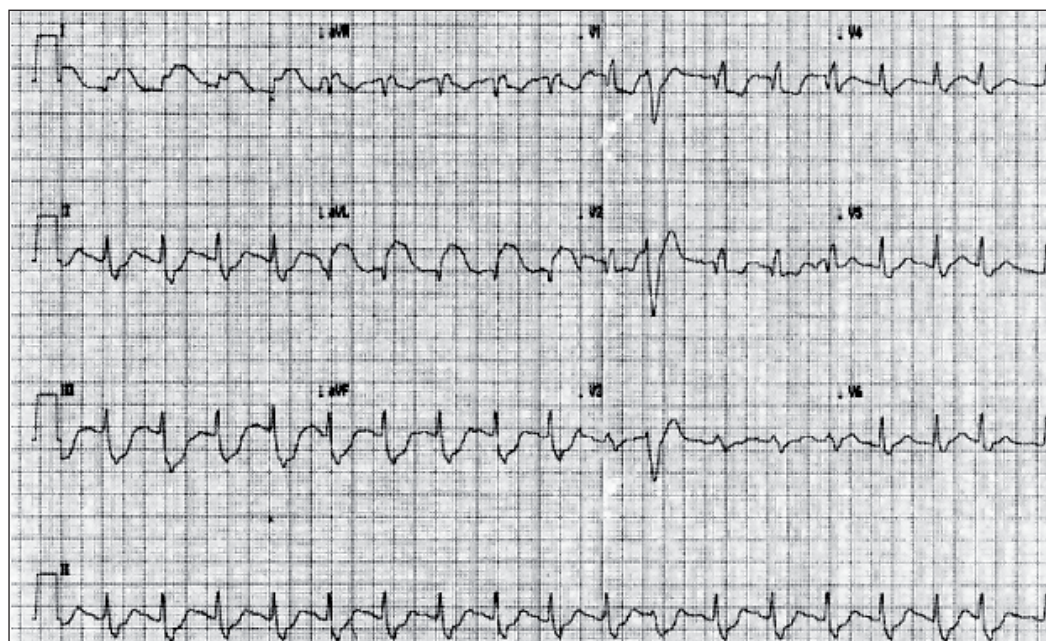


Fig. 1 – ECG: ST elevation in I and aVL.

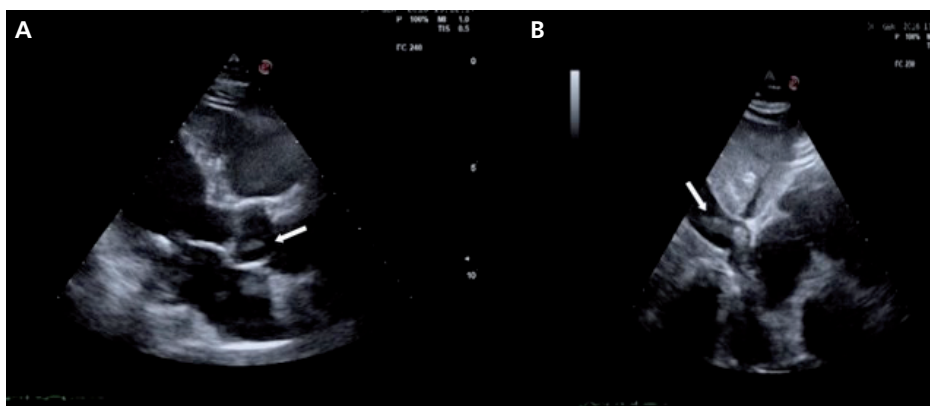


Fig. 3 – (A) Parasternal long axis view with evidence of formation adhering to the aortic cusp (arrow). (B) Subcostal view with evidence of filamentous formation, mobile in vena cava (arrow).

pulmonary hypertension (systolic pulmonary artery pressure [sPAP] 52 mmHg); in addition a low flow in the inferior vena cava vein with a pre-thrombotic state (sludge) was observed (Fig. 3B). Blood tests showed high troponin values (445 pg/ml), D-dimer > 40 µg/ml, C-reactive protein (CRP) 15.39 mg/dl, and normal procalcitonin. This clinical scenario was compatible with massive pulmonary embolism and consequent paradoxical embolism through the PFO.<sup>15,16</sup> Immediate fibrinolytic therapy with an alteplase bolus was started. During the infusion the clinical status was complicated by a pulseless electrical activity leading to death despite advanced life support.

## Discussion

As suggested by literature patent foramen ovale is the most common cardiac structural anomaly associated with paradoxical embolism.<sup>17</sup> This case demonstrates the dynamic nature of PFO because, even if functionally closed, a significant pressure overload in right chambers makes its reopening a possible eventuality, with a consequent right to left shunt and coronary and peripheral paradoxical embolism. Although it is a relatively rare event (2% of systemic arterial embolism), it can lead to possible severe prognosis, with a mortality rate of 21%.<sup>17</sup>

The purpose of this case report is to emphasize the importance of a careful screening for PFO even in asymptomatic patients and in those ones with an overt diagnosis a prompt advanced screening could be of prognostic importance. In fact patients with a patent foramen ovale > 4 mm with concomitant pulmonary embolism have a 5-fold higher risk of developing systemic embolism and a 10-fold higher risk to experience death than patients without patent foramen ovale.<sup>18</sup>

The most common clinical manifestation of paradoxical embolism is stroke;<sup>19</sup> less frequent is the occurrence of upper limb embolism, kidney ischemia, retinal artery occlusion. The occurrence of acute myocardial infarction with ST elevation is a rare event, as in our case. Paradoxical coronary embolization should be suspected in patients with chest pain and low cardiovascular risk profile.<sup>20</sup> Echocardiography is crucial for diagnosis, allowing preventive study of the interatrial septum with attention to the relationship between septum primum and secundum,

and to measure the amplitude of patency and the degree of left-to-right shunt (especially by transesophageal echocardiography).<sup>21</sup> This case demonstrates that a high level of suspicion should be maintained in these patients, performing a venous Doppler of the lower limbs as a screening for early detection of thrombosis, especially those ones with thrombophilia.<sup>22</sup> Exclusion of cardiac sources of embolism has particular importance in PFO patients with implanted cardiac devices.<sup>23</sup> A careful screening and, where appropriate, a prompt antithrombotic therapy<sup>24</sup> could be life-saving in some PFO patients, where a direct visualization of emboli crossing the foramen ovale could be too late.

## Conflict of interest

None.

## Funding body

None.

## Ethical statement

Authors state that the research was conducted according to ethical standard.

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