

## CASE REPORT

# Fatal asthma attributed to patent foramen ovale

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*Fatal asthma attributed to patent foramen ovale. E.S. Boon, B.L.P. Maesen, Y. Valcke, J. Koudstaal. ©ERS Journals Ltd 1993.*

**ABSTRACT:** A 37 year old woman was admitted to the hospital with acute severe asthma, shortly followed by respiratory failure and circulatory arrest. Despite intensive cardio-pulmonary resuscitation, during which extreme arterial hypoxaemia persisted, the patient died. Postmortem examination revealed a patent foramen ovale, with a diameter of 1 cm.

A severe right-to-left shunt, initiated by acute pulmonary hypertension, was considered to be the cause of death. Because of the relatively high prevalence of patent foramen ovale in the normal population, we suggest this patency may enhance the risk of fatal outcome of acute severe asthma.

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The overall incidence of a patent foramen ovale is 27%, as derived from an autopsy study of 965 normal hearts [1].

Functional closure is ensured by a pressure gradient between left and right atrium. However, during several disease states, in which pulmonary hypertension induces high right atrial pressure, a right-to-left shunt may occur. We report a case of acute fatal asthma, in which a severe right-to-left shunt across a patent foramen ovale caused irreversible arterial hypoxaemia, leading to death.

### Case report

A 37 year old woman was admitted to the emergency room with a status asthmaticus. The patient's medical history included bronchial asthma with severe bronchial hyperresponsiveness, previously treated by her house physician. No cardiological abnormalities were known.

A few days before admission, progressive dyspnoea was provoked by an upper respiratory infection. On the day of admission, the patient took 16 doses of aerosolized salbutamol (100 µg) without relief. She had not been using corticosteroids.

On physical examination, the patient was extremely dyspnoeic, with a breathing rate of 30 breaths·min<sup>-1</sup>, and central cyanosis. Blood pressure was 140/70 mmHg with pulsus paradoxus, and pulse rate 110 beats·min<sup>-1</sup>. The jugular veins were dilated to the jaws. On lung auscultation, breath sounds were hardly detectable, whereas heart sounds were soft without a murmur. An electrocardiogram (ECG) could not be taken because of severe respiratory distress.

Results of arterial blood gas analysis, while breathing 100% oxygen 15 l·min<sup>-1</sup> by face mask were: pH 7.37, arterial carbon dioxide tension (Paco<sub>2</sub>) 6.5 kPa, base excess -0.7 mmol·l<sup>-1</sup>, arterial oxygen tension (Pao<sub>2</sub>) 7.3 kPa, arterial

oxygen saturation (Sao<sub>2</sub>) 87%. Serum sodium was 140 mmol·l<sup>-1</sup> and potassium 4.2 mmol·l<sup>-1</sup>; haemoglobin 10 mmol·l<sup>-1</sup>, leucocytes 12.9×10<sup>9</sup>·l<sup>-1</sup> with 7% eosinophils in the differential white cell count.

In the emergency room, 10 mg salbutamol was nebulized with high oxygen flow through a face mask; 360 mg aminophylline and 100 mg prednisolone were given intravenously, and 0.5 mg terbutaline subcutaneously.

Despite this therapy, bronchospasm worsened, followed by respiratory arrest. The patient was intubated and manually ventilated. Initially, insufflation was hardly possible due to extreme bronchospasm and hyperinflation, but this subsided after tracheal instillation of 1 mg adrenaline. Cardiac resuscitation was started because of circulatory arrest; the monitor revealed asystole, preceded by extreme bradycardia.

Although ventilation was now easy with relatively low insufflation pressures, extreme cyanosis persisted.

A chest X-ray excluded barotrauma and confirmed proper position of the tracheal tube. The lung fields were oligoemic. Gas analysis of blood drawn from a femoral artery line showed: pH 6.92, Paco<sub>2</sub> 33.1 kPa, base excess +8.4 mmol·l<sup>-1</sup>, Pao<sub>2</sub> 1.7 kPa and Sao<sub>2</sub> 5%. Cardiopulmonary resuscitation was stopped because of irreversible arterial hypoxaemia, and the patient died. A severe right-to-left shunt was strongly suspected antemortem.

On postmortem examination, a patent foramen ovale was found, with a diameter of 1 cm (fig. 1a and b). Cardiac hypertrophy was absent. The microscopic specimen of the lungs revealed a bronchial mucosa predominantly infiltrated by eosinophils. The goblet cells were slightly hypertrophic, and there was smooth muscle hypertrophy. There was thickening of the epithelial basement membrane. Bronchial epithelial shedding and mucous plugs were absent and small, muscular pulmonary arteries looked normal, without signs of pulmonary hypertension of longer duration.

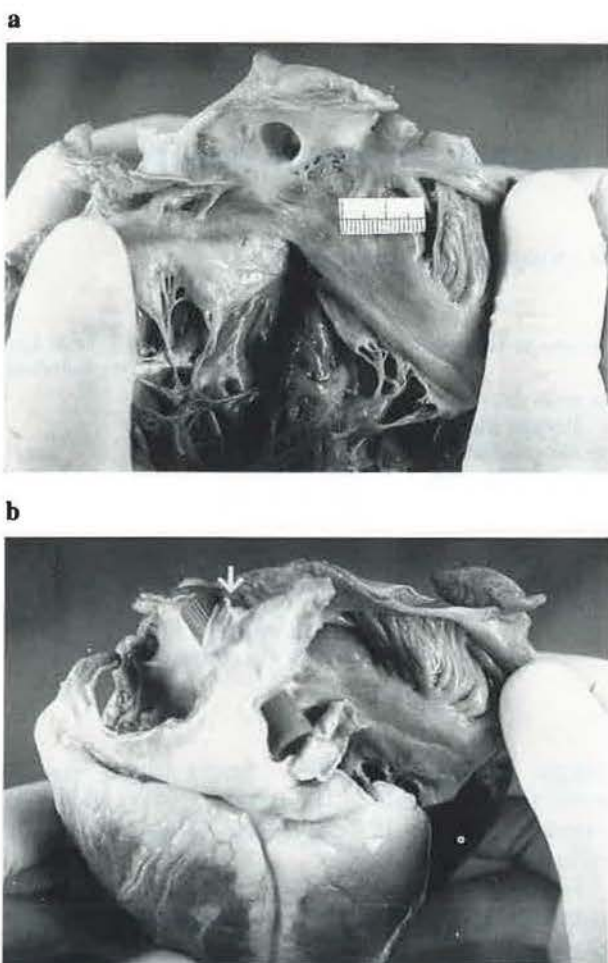


Fig. 1. — a) Opened right atrium with the patent foramen ovale. b) The cap of a style, penetrating the foramen ovale, revealing the valve on the side of the left atrium (arrow). Scale marker: large division is 1 cm.

### Discussion

The prevalence of patent foramen ovale on postmortem examination of normal hearts is 34% in the first three decades, declining during life due to closure. Sex distribution is equal. Size distribution is skewed, with 95% of cases smaller than 10 mm [1]. Physiological patency may be demonstrated by Valsalva manoeuvre contrast echocardiography in 18% of healthy persons of 18–25 yrs of age. The sensitivity of this method is 63% [2], while it is nearly 100% when performed by transoesophageal route [3]. Other useful techniques for demonstrating right-to-left shunting across a patent foramen ovale are dye dilution curves and angiography. Severe arterial hypoxaemia due to right-to-left shunting across a patent foramen ovale has been reported after lung surgery, e.g. lobectomy [4], pneumonectomy [5, 6], pulmonary embolism [6] and chronic obstructive pulmonary disease [7]. In the aforementioned situations, right-to-left shunting is induced by pulmonary hypertension.

In the present case, acute pulmonary hypertension during acute severe asthma presumably led to fatal, irreversible arterial hypoxaemia. Diagnostic procedures, such as contrast

echocardiography or angiography, were impossible because of cardiopulmonary arrest a few minutes after presentation in the emergency ward. Most striking was the irreversible arterial hypoxaemia, even when bronchospasm decreased and manual ventilation became easy. The very high partial  $Paco_2$  suggested dead space ventilation. Postmortem examination confirmed the proper position of the arterial line in the femoral artery. These features strongly suggest intracardiac shunting across a relatively large patent foramen ovale.

Although right-to-left shunting across a patent foramen ovale may be demonstrated in 18% of young, healthy adults, severe right-to-left shunts are rare, because these foramina are mostly small. The amount of shunting will differ between patients, depending on the anatomical relationship of the inferior vena cava and foramen ovale. Differences in right ventricular compliance between patients will also result in a different degree of right-to-left shunting [8].

More clinical research is needed to assess the role of patent foramen ovale in the outcome of status asthmaticus. Useful information may be gained by plotting dye dilution curves during acute severe asthma. Paradoxical embolism through a patent foramen ovale is now considered as the cause of stroke in some young adults [9]. Based on the present case, we propose that right-to-left shunting across a patent foramen ovale during acute severe asthma may account for some unexplained deaths [10] in young subjects.

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