

## IMAGE CHALLENGE

## A cardiac diagnosis by contrast echocardiography

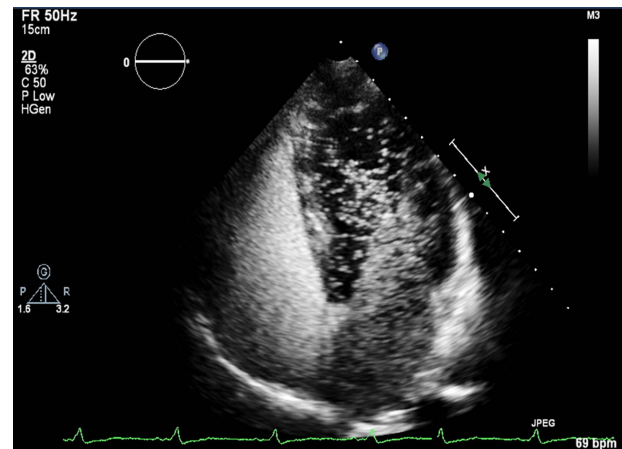
### INTRODUCTION

A middle-aged patient with a history of smoking and alcoholic liver cirrhosis was screened for liver transplantation. He had dyspnea on exertion. The EKG and chest X-ray revealed no abnormalities. Pulmonary function tests showed moderate obstruction. Arterial blood gas analysis revealed hypoxemia (saturation 89%) without significant orthodeoxia. On a 6 min walk test, saturation decreased to 82%. The AA-gradient was elevated (8.4 kPa). CT did not show any arteriovenous communications. Intrapulmonary shunting measured by conventional oxygen method and confirmed by radionuclide imaging was 19%. Transthoracic echocardiography demonstrated normal left and right ventricular size and function, mitral and aortic valves, and right heart pressures. To test for shunting, 5 mL of agitated colloid (gelofusine) mixed with patient's blood and mixed air was injected intravenously (figure 1, see online supplementary video 1).

### QUESTION

This contrast study is most consistent with:

- Normal physiology
- Atrial septum defect
- Patent foramen ovale
- Hepatopulmonary syndrome
- None of the above



**Figure 1** Echocardiography: Apical four chamber view five cycles after injection of contrast.

Opacification of the right heart was seen, and 4–5 cycles later, with massive amounts of air bubbles, appeared in left atrium ventricle (figure 1) by right-to-left shunting. Agitated colloid has the same properties as saline, however, it retains its turbidity longer and air bubbles are more stable which results in stronger opacification.<sup>1</sup>

For answers see page 661

**To cite** Brugts JJ, Michels M, den Uil CA. *Heart* 2014;**100**:657.

*Heart* 2014;**100**:657. doi:10.1136/heartjnl-2014-305523

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**ANSWER: D**

From question on page 657

The correct answer is D. The hepatopulmonary syndrome is a rare condition which occurs in patients with both chronic and acute liver failure and results from the formation of microscopic intrapulmonary arteriovenous dilatations.<sup>2</sup> The mechanism is not exactly known. The syndrome may be caused by increased hepatic production of vasodilators, such as nitric oxide, which causes a ventilation perfusion mismatch (relative overperfusion) and hypoxemia on exertion.<sup>1</sup> Additionally, an increased gradient between the partial pressure of oxygen in the pulmonary alveoli and adjacent arteries (alveolar-arterial (A-a) gradient) exists.<sup>2</sup> Ultimately, these patients develop high output failure. The only causative treatment is urgent liver transplantation.<sup>2</sup>

Answer A is incorrect as it is abnormal to see any air bubbles in the left atrium which should not pass the pulmonary vascular bed. Answers B and C are incorrect, as in these cases, the air bubbles will be seen <3 cardiac cycles in the left atrium. The atrial septal defect results in a left-to-right shunt primarily, however, a small amount of right-to-left shunting as right atrium (RA) and left atrium (LA) pressures crossover can

sometimes be seen, the amount of air bubbles and the timing of the appearance of air bubbles refute the diagnosis of atrial septal defect (ASD). The patent foramen ovale results in a right-to-left shunt during pressure elevations (after which bubbles will occur). Answer E is also incorrect.

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**Contributors** All authors contributed to the submitted manuscript.

**Competing interests** None.

**Provenance and peer review** Not commissioned; internally peer reviewed.

► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/heartjnl-2014-305523>).

**To cite** Brugts JJ, Michels M, den Uil CA. *Heart* 2014;**100**:661.

Received 14 January 2014

Revised 15 January 2014

Accepted 16 January 2014

*Heart* 2014;**100**:661. doi:10.1136/heartjnl-2014-305523a

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- 2 Rodriguez-Roisin R, Krowka MJ. Hepatopulmonary syndrome—a liver-induced lung vascular disorder. *N Engl J Med* 2008;**358**:2378–87.