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## Reversibility of cardiopulmonary impairment after laparoscopic repair of large hiatal hernia



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## ABSTRACT

Giant hiatus hernia with or without intrathoracic gastric volvulus often presents with symptoms suggestive of both cardiac and pulmonary compression. Cardiopulmonary impairment may be reversible in these patients by laparoscopic crural repair and fundoplication as shown in this case report. Cardiac magnetic resonance and the cardiopulmonary exercise test may help selecting patients for surgery. These preliminary findings led us to start a prospective study using this multimodality diagnostic approach.

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A 45-year-old man with a body mass index of 36 was referred to our outpatient clinic with a 3-month history of postprandial fullness, dyspnea (NYHA class III), and palpitations. He had no severe comorbidities, except for obstructive sleep apnea syndrome, and a family history of gastric cancer. His vital signs, physical examination, and results of blood tests were unremarkable.

A barium swallow study showed herniation of the whole stomach into the thorax with rotation along the longitudinal axis. A thoraco-abdominal CT scan demonstrated a large paraesophageal hernia with compression of the left atrium. An upper gastrointestinal endoscopy, done under sedation and with low gas inflation, revealed grade B esophagitis and a giant hiatal hernia with twisting of the intrathoracic stomach. It was impossible to visualize and pass the pylorus.

Electrocardiogram and pulmonary function tests were unremarkable. Transthoracic echocardiography showed normal heart morphology and function. Cardiopulmonary exercise test (CPET) was performed to clarify the nature of dyspnea and showed significant reduction of effort tolerance (peak  $\text{VO}_2$  20.1 ml/kg/min, corresponding to 57% of predicted  $\text{O}_2$  consumption) and maximal ventilation (peak ventilatory equivalents 64 l/min, corresponding to 52% of the predicted).

To evaluate the impact of the stomach on the cardiac function, a Cardiac Magnetic Resonance (CMR) on a 1.5-Tesla equipment was performed in the fasting condition and immediately after a standard meal\*. Using dedicated ECG-gated true-FISP and SSFP cine sequences, the volume of the cardiac chambers was assessed. Compared to baseline, a marked decrease of right atrial volume (from 113 to 92 ml) and left atrial volume (from 69 to 59 ml) was noted after meal (Fig. 1a and b).

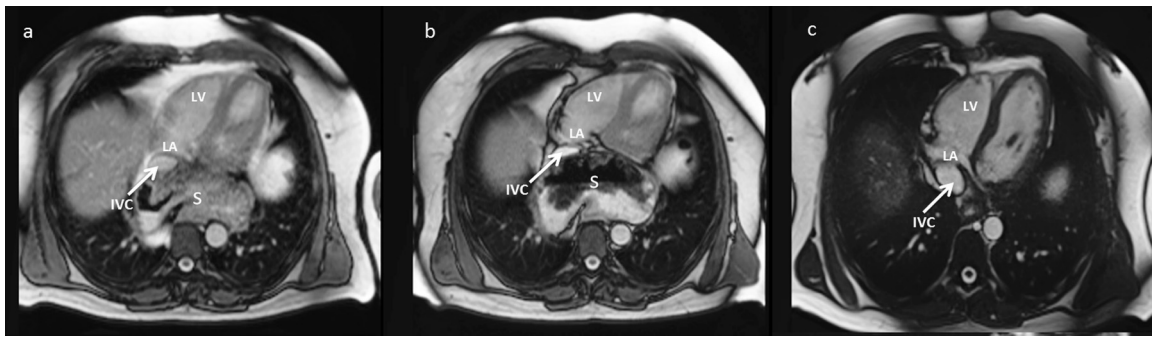
The patient underwent laparoscopic reduction of the herniated stomach with complete excision of a retrogastric lipoma and the hernia sac. Both anterior and posterior vagal nerves were preserved. Primary posterior-lateral cruroplasty was then performed using non absorbable sutures. The hiatus repair was reinforced with a synthetic absorbable mesh (Gore Bio-A®). Finally, a Toupet fundoplication was performed. The patient was discharged home on postoperative day 2.

At 3-month follow up the CMR scan showed a decreased right atrium volume and an increase of the left heart section volumes presumably due to improved venous inflow (Fig. 1c). Upper gastrointestinal endoscopy, pulmonary function tests and echocardiography were normal. CPET showed a dramatic improvement of exercise (peak  $\text{VO}_2$  27.5 ml/kg/min, corresponding to 78% of predicted  $\text{O}_2$  consumption) and ventilatory capacity (peak ventilatory equivalents 103 l/min, corresponding to 83% of the predicted) (Fig. 2).

Large hiatal hernias with or without intrathoracic gastric volvulus generally occur in elderly individuals and are commonly

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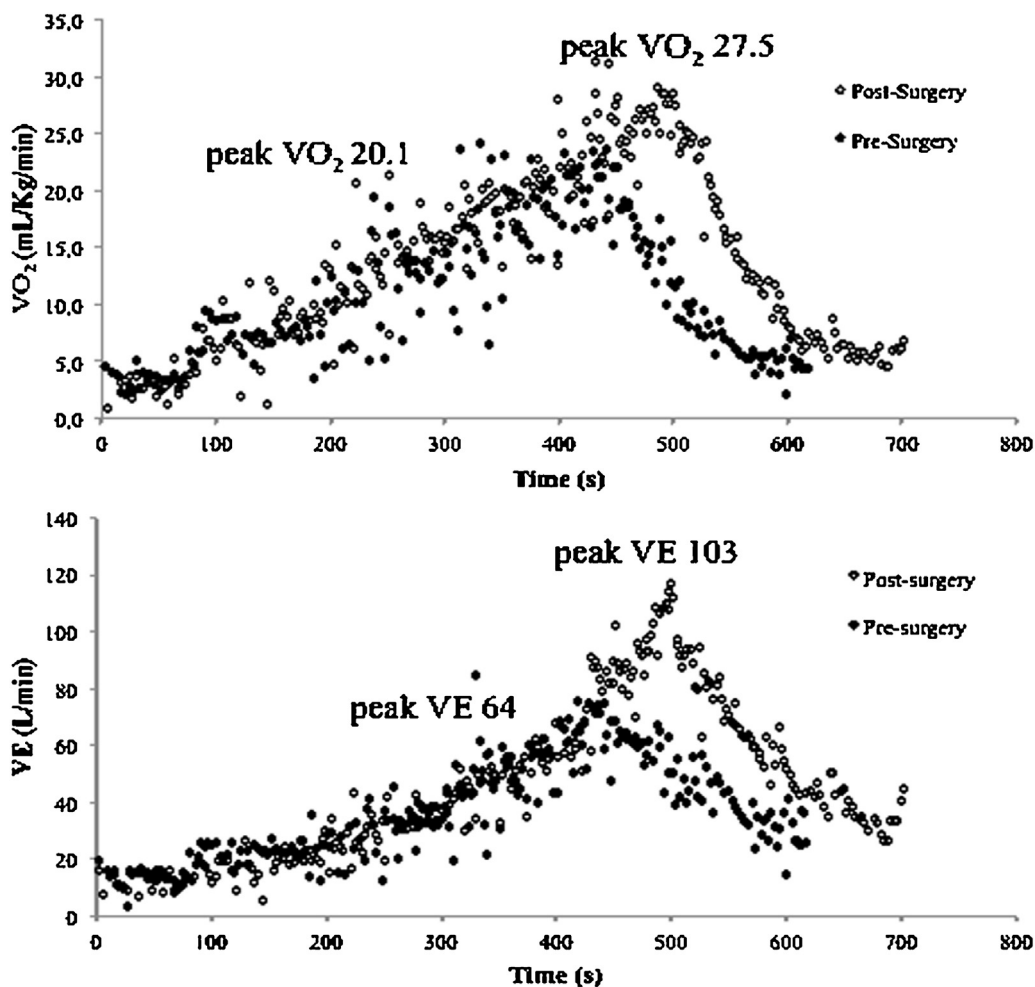


**Fig. 1.** Preoperative CMR scan before meal showing intrathoracic stomach (a); increase in size of the hiatus hernia after a standard meal (b); postoperative CMR scan showing disappearance of the hernia and regular shape of the inferior vena cava (c). (LA Left atrium, LV Left ventricle, S stomach, IVC Inferior vena cava).

associated with cardiorespiratory distress. CT scan involves X-ray exposure and does not allow to assess the dynamic impact of a herniated stomach on cardiac function [1]. CMR has been shown to be a more valuable diagnostic tool in this setting [2]. The addition of a standard meal may be useful to assess the morphology of the intrathoracic stomach and to dynamically quantify the degree of atrial and ventricular volumes and the changes in ventricular volumetric adaptation after surgical repair. Moreover, CPET is useful to assess the degree of functional limitation and the impact on exercise and ventilator capacity.

Cardiopulmonary impairment may be reversible in patients with large hiatal hernia. CMR and CPET may help selecting patients for surgery. These preliminary findings led us to start a prospective study using this multimodality diagnostic approach. At present, 18 patients have completed the pre-operative assessment and 11 of them have undergone laparoscopic repair. Postoperative follow-up is in progress.

\*The standard test meal included the following: bar with cereals and seeds (flax, pumpkin and sunflower seeds, spelt, millet, kamut and amaranth cereals, honey, almonds, rolled oats, walnut, quinoa.



**Fig. 2.** VO<sub>2</sub> (oxygen consumption) and VE (ventilatory equivalent) versus time, before and after (black and white circle) surgery, showing the consistent improvement of both parameters.

Weight 25 g, Kcal 111, fat 5.65 g, carbohydrates 10.3 g, fiber 2.62 g, proteins 3.75 g, salt 9.38 mg); liquid yogurt (milk, lactobacillus 17%, saccharose, water, lemon juice, strawberry, pectin, red fruit juice, flavoring, potassium sorbate. Weight 250 mg, Kcal 84.6, fat 1.8 g, carbohydrates 14.5 g, proteins 2.6 g, salt 0.1 g); water (500 ml).

#### Conflict of interest

Nothing to declare.

#### Funding

Nothing to declare.

#### Ethical approval

Internal Review Board at IRCCS Policlinico San Donato approved this study.

#### Consent

Fully informed written and signed consent was given by the patient.

#### Author contributions

All authors contributed to study design, data collection, data analysis and interpretation.

#### Research registry

Studies done in the patient were not experimental but part of routine clinical work up.

#### Guarantor

Luigi Bonavina.

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