

## Case Report

## Esmolol Facilitated Extubation in a Patient with Severe Systolic Dysfunction Following Myocardial Infarction

APOSTOLOS KARAVIDAS, GEORGE LAZAROS, SOPHIA ARAPI, XENIA GRIVA,  
EVANGELOS MATSAKAS

*Cardiology Department, Athens General Hospital, Athens, Greece*

Key words:

**Esmolol, tracheal extubation, left ventricular dysfunction, myocardial infarction.**

We describe the case of a 59-year-old-man with acute myocardial infarction and severely impaired left ventricular systolic function who was intubated because of recurrent ventricular fibrillation in the setting of coronary angioplasty. Repeated ventilator weaning attempts and extubation initially failed, as severe tachycardia and hypertension occurred each time the patient began to awaken. Pre-treatment with esmolol infusion prevented the above haemodynamic changes, allowing successful extubation. Esmolol administration at ventilator weaning seems to be a safe and effective option, even in selected patients with impaired left ventricular contractility.

*Manuscript received:*  
September 19 2007;  
*Accepted:*  
October 16 2007.

*Address:*  
George Lazaros

31 Achilleos St  
175 62 P. Faliron,  
Athens, Greece  
*e-mail:*  
[glaz35@hotmail.com](mailto:glaz35@hotmail.com)

**I**t has been shown that tracheal extubation may be associated with tachycardia and hypertension after withdrawal of anaesthesia.<sup>1</sup> However, this adrenergic stress response is poorly tolerated in patients with coronary artery disease, potentially leading to myocardial ischaemia-infarction, and/or acute pulmonary oedema.<sup>2</sup>

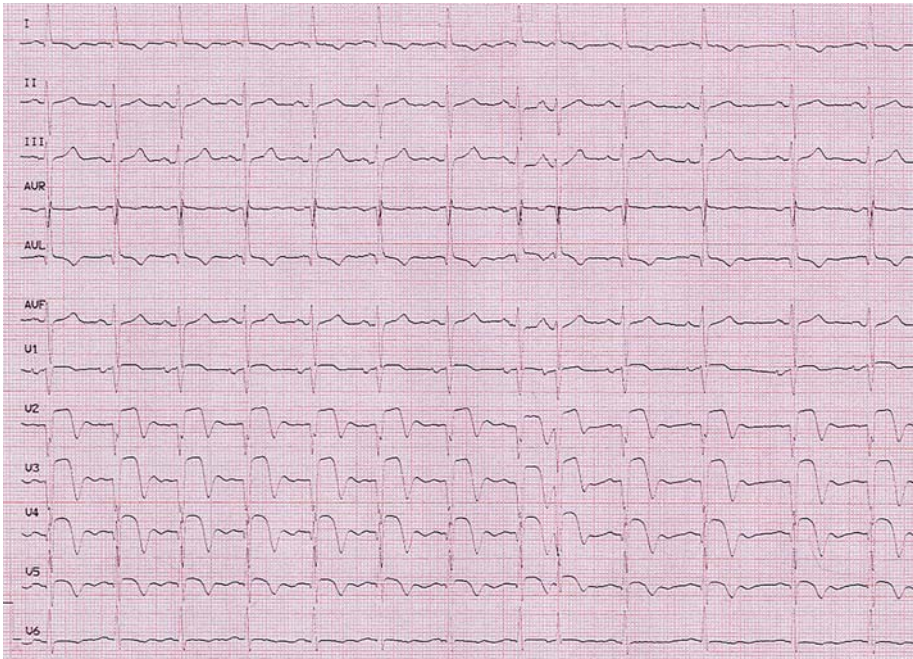
We report the case of a patient with a recent myocardial infarction and severely depressed left ventricular systolic function, who developed recurrent episodes of acute pulmonary oedema during ventilator weaning attempts, due to the uncontrolled rise of blood pressure and heart rate. Pre-treatment with esmolol infusion, in spite of the low ejection fraction, prevented the adverse haemodynamic changes and resulted in a successful extubation.

### Case presentation

A 59-year-old-man came to the emergency department of our hospital complaining of

chest pain lasting approximately 11 hours and worsening dyspnoea. There was a long history of arterial hypertension treated with amlodipine 10 mg daily. The patient was afebrile, the pulse was 100 and respiration 23 per minute. The blood pressure was 190/100 mmHg. On physical examination cardiac auscultation revealed a Grade 2 systolic murmur along with a third protodiastolic gallop sound (S<sub>3</sub>) in the apical region. Diffuse moist rales and wheezes were present in both lungs.

An electrocardiogram showed sinus tachycardia at a rate of 100 beats/min, QS waves in leads V<sub>1</sub> to V<sub>3</sub> along with ST elevation in leads V<sub>1</sub> to V<sub>5</sub> and occasional supraventricular beats (Figure 1). An echocardiographic examination performed at bedside revealed severely depressed left ventricular contractility (ejection fraction of 35% as measured using the Simpson's rule technique) due to apical akinesis and hypokinesis of the interventricular septum and anterior wall. Mild left ventricular dilatation and concentric hypertrophy were

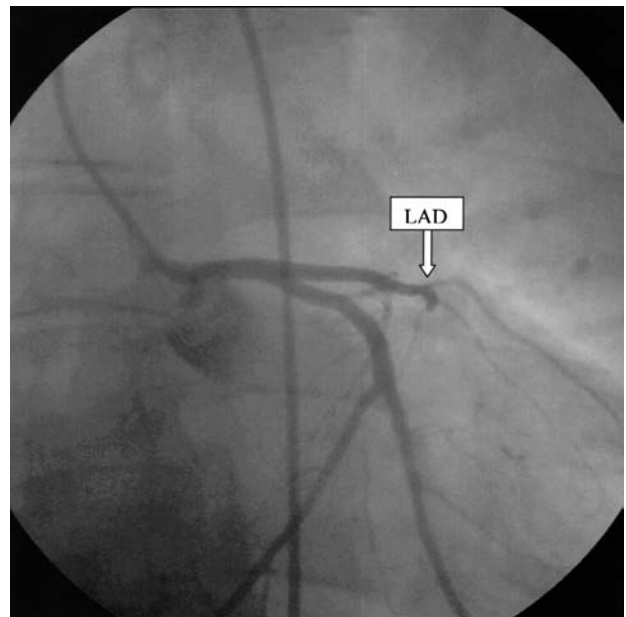


**Figure 1.** Electrocardiographic recording obtained on admission, compatible with acute anterior myocardial infarction.

also detected (end-diastolic diameter 58 mm, interventricular septum thickness 13 mm, posterior wall thickness 12.5 mm). In contrast, right ventricular dimensions and contractility were not affected. Pulse wave Doppler examination of the transmitral flow revealed a restrictive pattern, whilst colour flow Doppler revealed mild mitral and tricuspid regurgitation, with an estimated right ventricular systolic pressure of approximately 50 mmHg. Finally, blood chemical analysis revealed an increase in troponin I (26 ng/ml peaking at 180 ng/ml; normal values <0.04) and in other serum markers of myocardial damage.

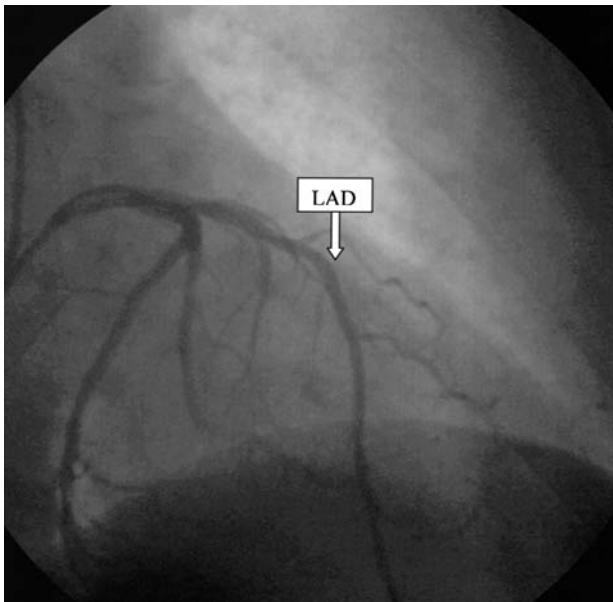
Taking into account the above findings, the diagnosis of acute anterior myocardial infarction complicated by pulmonary oedema was established, and the patient was admitted to the coronary care unit. He was initially treated with supplemental oxygen, unfractionated heparin, acetylsalicylic acid, clopidogrel, angiotensin converting enzyme inhibitor, nitrates, bronchodilators, and furosemide.

Two hours later and after initial stabilisation, the patient underwent coronary angiography, which revealed a totally occluded left anterior descending coronary artery after the first septal branch, whilst left circumflex and right coronary arteries were free of stenosis (Figure 2). As the patient continued to complain of chest discomfort, percutaneous coronary angioplasty was attempted. Unfortunately, during the first balloon inflation the patient suffered recurrent episodes of ventricular fibrillation treated with defib-



**Figure 2.** Coronary angiogram, anteroposterior view disclosing a total (100%) occlusion of the left anterior descending coronary artery (LAD) after the first septal and diagonal branch.

rillation. Cardiopulmonary resuscitation was promptly applied, and intubation was instituted followed by artificial ventilation. With the patient sedated and intubated the procedure was continued, and a stent was implanted in the left anterior descending artery with an optimal final result (Figure 3). However, although TIMI 3 flow was achieved in the culprit vessel, the pa-



**Figure 3.** Coronary angiogram after angioplasty of the left anterior descending coronary artery branch (LAD) with stent implantation, revealing an optimal final result (TIMI 3 flow).

tient presented persisting haemodynamic deterioration and intraaortic balloon counterpulsation was started along with norepinephrine infusion, so as to obtain a mean blood pressure above 70 mmHg.

Three days later the patient stabilised, the dose of norepinephrine was tapered, aortic counterpulsation was discontinued, and weaning from mechanical ventilation was attempted. However, after the patient had been completely awakened and ventilated with continuous positive airway pressure at 15 mmHg, a gradual rise of systolic blood pressure (up to 200 mmHg, in spite of IV infusion of nitrates at a dose titrated up to 0.1 mg/min) and of the heart rate (up to 130 beats/min) was observed. Unfortunately, soon his respiration became more frequent and shallow, the oxygen saturation fell below 90% and moist rales were heard at the basal pulmonary fields, a picture compatible with acute pulmonary oedema. As a result, the patient was sedated once again with propofol and midazolam, and mechanical ventilation was reintroduced with a tidal volume of 650 ml, at a rate of 13 breaths/min and an oxygen concentration of 40%. In addition, right heart catheterisation was performed with a Swan-Ganz catheter; the measurements are presented in Table 1. Two more weaning attempts in the following 72 hours failed, always resulting in pulmonary oedema due to an abrupt and uncontrolled rise of blood pressure and heart rate, with gradual elevation of pulmonary capillary wedge pressure (from

16 up to 27 mmHg; Table 1). Serial electrocardiograms and echocardiograms revealed no significant changes as compared with the initial ones, nor was any further increase detected in the serum markers of cardiac damage.

After the patient had been sedated and intubated for 6 days, under treatment with angiotensin converting enzyme inhibitor, nitrates, furosemide, acetylsalicylic acid, clopidogrel and low molecular weight heparin, a further ventilator weaning attempt was undertaken. This time, however, esmolol at an initial rate of 50 µg/kg/min was administered additionally before the patient began to awaken. For the effective control of both blood pressure and heart rate, a gradual upward titration of esmolol infusion was required to a maximum dose of 150 µg/kg/min. On this occasion, the systolic blood pressure was maintained below 130 mmHg, the heart rate below 80 beats/min and the pulmonary capillary wedge pressure did not exceed 18 mmHg. Consequently, four hours later the patient was successfully extubated. The infusion rate of esmolol and nitrates was gradually tapered, and both drugs were finally discontinued approximately 24 hours after extubation. The remainder of the in-hospital course was event free, and the patient was discharged 5 days later in a fair condition.

## Discussion

In patients with coronary artery disease, the cardiovascular responses during extubation have deleterious effects on myocardial performance.<sup>3</sup> Withdrawal of anaesthesia during ventilator weaning attempts results in an increase of the rate-pressure product immediately before tracheal extubation, due to catecholamine secretion.<sup>4</sup> As a result, myocardial ischaemia or pulmonary oedema (or both) may occur, especially in patients with pre-existing coronary artery disease.<sup>2,3,5</sup> Thus, control of the haemodynamic responses, such as pulse rate and blood pressure, is extremely important during ventilator weaning, especially when we are dealing with patients suffering from coronary artery disease and/or impaired left ventricular performance.

To suppress the adverse haemodynamic changes of anaesthesia withdrawal and extubation, several prophylactic measures have been tested. Among them, opiate analgesics may blunt these responses, but their use is affected by their dose-dependent respiratory depressant effect.<sup>1</sup> Other options include nicardipine (which, however, appears mainly effective in lowering blood pressure response rather than controlling heart rate), dexmedetomi-

**Table 1.** Values of various cardiovascular parameters measured before and after esmolol infusion.

	Initial readings (with the patient sedated)	At ventilator weaning (2nd attempt)	Before extubation (under esmolol infusion)	2 hours after extubation (still under esmolol infusion)
HR (beats/min)	80	130	78	70
SBP (mmHg)	130	200	120	115
PCWP (mmHg)	17	27	18	15
CI (ml/min/m <sup>2</sup> )	2.7	3.5	3.3	3.5
SaO <sub>2</sub> (%)	98	87	98	97

HR – heart rate; SBP – systolic blood pressure; PCWP – pulmonary capillary wedge pressure; CI – cardiac index; SaO<sub>2</sub> – arterial oxygen saturation.

dine, and finally esmolol.<sup>1,2,6-8</sup> Dexmedetomidine is a selective  $\alpha_2$ -adrenoreceptor agonist with sedative and analgesic effects. Unfortunately, this agent is not available in our country, and furthermore it must be infused with caution in patients with impaired ventricular function (because of a decrease of the cardiac index), as was the case in our patient.

Esmolol is an ultra-short-acting cardioselective beta adrenoreceptor antagonist, with a rapid onset and short duration of action (9 min half-life), and a rapid elimination.<sup>9</sup> The pharmacokinetics of esmolol render this agent particularly suitable for conditions of high catecholamine output, such as emergence from general anaesthesia and tracheal extubation. Indeed, it has been shown that prophylactic esmolol infusion can safely and effectively control the haemodynamic disturbances during extubation in patients either with or without coronary artery disease.<sup>1,7,10,11</sup> Doses of 1.5-2 mg/kg appear sufficient to control both systolic blood pressure and heart rate, but the larger dose may produce significant decreases in systolic blood pressure.<sup>12</sup>

In the case described here, a patient with acute myocardial infarction complicated by pulmonary oedema was intubated following recurrent ventricular fibrillation in the setting of coronary angioplasty. Although reperfusion is an absolute prerequisite for the survival of ischaemic tissue, it is well known that reperfusion can be detrimental by causing arrhythmias and can contribute to myocardial stunning.<sup>13</sup> Several ventilator weaning attempts in our patient failed, because of uncontrolled arterial hypertension and tachycardia secondary to the catecholamine response. The increased cardiac work inevitably led to acute pulmonary oedema in all attempts. Pre-treatment with esmolol infusion, in a careful dose titration, effectively blunted the above cardiovascular responses (without practically affecting heart perfor-

mance, as shown in Table 1) and allowed successful extubation.

An improved outcome of patients with chronic systolic heart failure after treatment with beta-blockers has been shown in several randomised controlled trials.<sup>14</sup> It is noteworthy that, in general, pulmonary oedema due to impaired left ventricular systolic function constitutes a contraindication to beta-blocker administration. However, the cause of cardiac decompensation in this specific patient was the abrupt increase in the double product and not the cardiac compromise *per se*. Moreover, in a study where patients with acute myocardial infarction and relative contraindications to beta-blocker therapy were enrolled (including active signs/symptoms of left ventricular dysfunction or a history of congestive heart failure), esmolol infusion has been proved safe and effective.<sup>15</sup>

We conclude that esmolol infusion offers an attractive alternative for preventing or controlling the adverse haemodynamic responses to extubation, which are particularly deleterious in patients with coronary heart disease. The agent seems also to be safe even in selected patients with impaired left ventricular contractility. The short half-life of the medicine makes it safe to use because any adverse effect can be rapidly reversed.

## References

- O'Dwyer JP, Yorukoglu D, Harris MN: The use of esmolol to attenuate the hemodynamic response when extubating patients following cardiac surgery – a double-blind controlled study. *Eur Heart J* 1993; 14: 701-704.
- Duane DT, Redwood SR, Grounds RM: Esmolol aids extubation in intensive care patient with ischaemic pulmonary edema. *Anaesthesia* 1996; 51: 474-477.
- Edwards ND, Alford AM, Dobson PM, et al: Myocardial ischemia during tracheal intubation and extubation. *Br J Anaesth* 1994; 73: 537-539.
- Lowrie A, Johnston PL, Fell D, Robinson SL: Cardiovascular

- and plasma catecholamine responses at tracheal extubation. *Br J Anaesth* 1992; 68: 261-263.
5. Welwood M, Aylmer A, Teasdale S, et al: Extubation and myocardial ischemia. *Anesthesiology* 1984; 61: A132.
  6. Kovac AL, Masiongale A: Comparison of nicardipine versus esmolol in attenuating the hemodynamic responses to anaesthesia emergence and extubation. *J Cardiothorac Vasc Anesth* 2007; 21: 45-50.
  7. Wang YQ, Guo QL, Xie D: Effects of different doses of esmolol on cardiovascular responses to tracheal extubation. *Hunan Yi Ke Da Xue Xue Bao* 2003; 28: 259-262.
  8. Blake DW: Dexmedetomidine and hemodynamic responses to simulated hemorrhage in experimental heart failure. *Anesth Analg* 2000; 91: 1112-1117.
  9. Gorczynski RJ, Shaffer JE, Lee RJ: Pharmacology of ASL-8052, a novel beta-adrenergic receptor antagonist with an ultrashort duration of action *J Cardiovasc Pharmacol* 1983; 5: 668-677.
  10. Lim SH, Chin NM, Tai HY, Wong M, Lin TK: Prophylactic esmolol infusion for the control of cardiovascular responses to extubation after intracranial surgery. *Ann Acad Med Singap* 2000; 29: 447-451.
  11. Arar C, Colak A, Alagol A, et al: The use of esmolol and magnesium to prevent haemodynamic responses to extubation after coronary artery grafting. *Eur J Anaesthesiol* 2007; 24: 826-831.
  12. Dyson A, Isaac PA, Pennant JH, Giesecke AH, Lipton JM: Esmolol attenuates cardiovascular responses to extubation. *Anesth Analg* 1990; 71: 675-678.
  13. Bolli R: Reperfusion-induced injury. Manifestations, mechanisms and clinical relevance. *Cardiovasc Res* 1992; 26: 101-108.
  14. Liberopoulos EN, Elisaf MS: Clinical use of nebivolol in the treatment of chronic heart failure. *Hellenic J Cardiol* 2005; 46: 208-211.
  15. Mooss AN, Hilleman DE, Mohiuddin SM, Hunter CB: Safety of esmolol in patients with acute myocardial infarction treated with thrombolytic therapy who had relative contraindications to beta-blocker therapy. *Ann Pharmacother* 1994; 28: 701-703.