

Harmful effect of epinephrine on postreperfusion syndrome in an elderly liver transplantation recipient with sigmoid ventricular septum

A case report

Young-Jin Moon, MD, Ji Hyun Park, MD, JongEun Oh, MD, Sooho Lee, MD, Gyu-Sam Hwang, MD*

Abstract

Introduction: As a common morphological change of aging heart, sigmoid ventricular septum is frequently found during routine preoperative evaluation, but often disregarded because of its little clinical importance. However, in this report, we describe a 70-year old patient with sigmoid ventricular septum who developed severe hemodynamic deterioration during liver transplantation because of its unique morphology of heart.

Methods: During the course of reperfusion of the graft, patient's hemodynamics were closely monitored using transesophageal echocardiography.

Results: Immediately after graft reperfusion, epinephrine was given as a treatment of choice for postreperfusion syndrome. Surprisingly, however, hemodynamic derangement persisted and became even worse. Intraoperative transesophageal echocardiography revealed left ventricular outflow tract obstruction resulting from systolic anterior motion of the mitral valve leaflet. Therefore, the patient was treated with phenylephrine and fluid bolus under the guidance of transesophageal echocardiography.

Conclusion: As more elderly recipient present for liver transplantation surgery nowadays, left ventricular outflow tract obstruction should always be considered as a possible cause for hemodynamic instability during reperfusion period. In addition, transesophageal echocardiography is a useful tool for both diagnosis of hemodynamic derangement and guidance for appropriate management during liver transplantation surgery.

Abbreviations: LT = liver transplantation, LVOT = left ventricular outflow tract, PRS = postreperfusion syndrome, SAM = systolic anterior motion, SvO₂ = mixed venous oxygen saturation, SVR = systemic vascular resistance, SVS = sigmoid ventricular septum, TEE = transesophageal echocardiography, TTE = transthoracic echocardiography.

Keywords: epinephrine, left ventricular outflow tract obstruction, liver transplantation, postreperfusion syndrome, sigmoid septum, systolic anterior motion of mitral valve leaflet, transesophageal echocardiography

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Department of Anesthesiology and Pain Medicine, Laboratory for Cardiovascular Dynamics, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea.

* Correspondence: Gyu-Sam Hwang, Department of Anesthesiology and Pain Medicine, Laboratory for Cardiovascular Dynamics, Asan Medical Center, University of Ulsan College of Medicine, 88, Olympic-ro 43-gil, Songpa-gu, Seoul, Korea (e-mail: kshwang@amc.seoul.kr).

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1. Introduction

A sigmoid ventricular septum (SVS) is a morphological change of the heart characterized by angulation between the ascending aorta and the basal ventricular septum.^[1,2] This morphological change has been considered a normal aging process involving elongation or tortuosity of the ascending aorta.^[1,3] Because an SVS is frequently observed on echocardiography and has no clinical implications in most subjects, not much attention may have been paid to this feature in daily clinical practice.^[4] However, in certain clinical circumstances, an SVS has been reported to cause left ventricular outflow tract (LVOT) obstruction, which may result in a severe hemodynamic derangement.^[3,5,6]

Because of an increasing survival rate and larger number of elderly liver transplantation (LT) recipients, anesthesiologists may face an increasing incidence of SVSs in LT surgery.^[7] During the reperfusion period from LT surgery, characteristic hemodynamic changes, known as postreperfusion syndrome (PRS), often occur.^[8] Nevertheless, this potential risk from an SVS has been largely overlooked to date because severe hemodynamic perturbation has not been reported in LT patients with cardiac morphological changes. Herein, we describe a 70-year-old patient whose pretransplant echocardiography was reported as normal, although an SVS was seen during the examination.

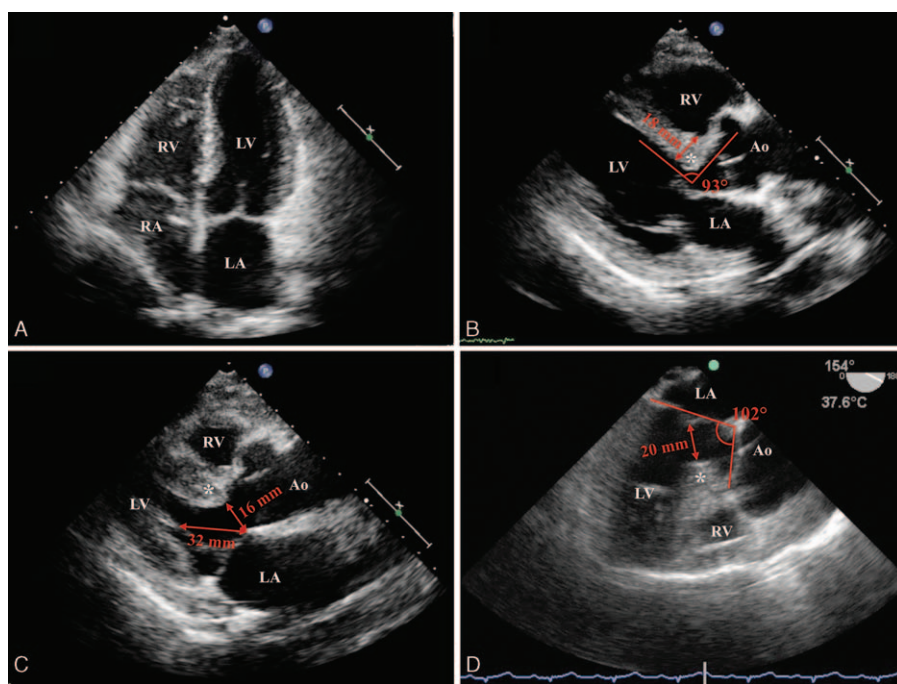


Figure 1. Preoperative TTE and intraoperative TEE of the study patient are shown. The apical 4-chamber view of the TTE appears normal (A) but the parasternal long-axis view of the TTE demonstrated an SVS (asterisk). The end-diastolic thickness of the SVS was 18 mm, and the angle between the basal septum and ascending aorta was 93° (B). In end-systole, the leaflet tethering distance was measured as 32 mm, and the left ventricular outflow tract diameter was measured as 16 mm (C). The mid-esophageal long-axis view of TEE showed a mitral-aortic angle (the angle formed by the intersection of the mitral annulus and aortic annulus) of 102° and C-sept distance (distance from the mitral coaptation point to the septum) of 20 mm (D). Ao = aorta, LA = left atrium, LV = left ventricle, RA = right atrium, RV = right ventricle, SVS = sigmoid ventricular septum, TEE = transthoracic echocardiography, TTE = transthoracic echocardiography.

Severe hemodynamic instability occurred after administration of a small dose of epinephrine, the drug of choice for the treatment of PRS, because of a LVOT obstruction with systolic anterior motion (SAM) of the mitral valve leaflets after reperfusion of the graft.

2. Clinical presentation

We obtained the written informed consent from the patient for publication of this case report and accompanying images. A 70-year-old male patient diagnosed with hepatitis C virus-related liver cirrhosis was scheduled for living donor LT. His past medical history was unremarkable. The preoperative electrocardiogram showed normal sinus rhythm without ST- or T-wave abnormalities. His chest radiograph showed a normal heart size with mild pleural effusion because of a large amount of cirrhotic ascites. Routine preoperative transthoracic echocardiography (TTE) showed a hyperdynamic left ventricle with normal systolic function and an ejection fraction of 65%. The end-diastolic thickness of both the interventricular septum and posterior wall was 9 mm, which was in the normal range. The mitral valve had a normal morphology with trivial regurgitation. Continuous-wave Doppler of the LVOT showed a peak systolic flow velocity of 1.25 m/s, which corresponded to a pressure gradient of 6 mm Hg. The overall conclusion was a normal echocardiogram by a cardiologist and did not mention the presence of SVS (Fig. 1). Upon arrival in the operating room, the patient's blood pressure was 103/60 with heart rate of 60 bpm. After applying standard monitoring, general anesthesia was induced with 200 mg thiopental sodium, 5 mg midazolam, and 100 mcg fentanyl. Neuromuscular blockage was achieved with 10 mg vecuronium,

and anesthesia was maintained with a continuous infusion of fentanyl and 1 vol% sevoflurane in a 50% air/oxygen mixture. After endotracheal intubation, the radial and femoral arteries were cannulated for continuous blood pressure monitoring. Blood pressure waveforms were digitized and recorded during entire period of LT surgery. Two central venous cannulations for a pulmonary artery catheter and a large-bore catheter were placed in the right internal jugular vein. Transesophageal echocardiography (TEE) was placed to guide the intraoperative management.

After 7 hours of uneventful preanhepatic and anhepatic phases, graft reperfusion was performed with unclamping of the hepatic and portal veins. Shortly after, PRS occurred with a decreased blood pressure as low as 49/27 mm Hg. Mixed venous oxygen saturation (SvO_2) did not decrease, and TEE showed normal contractility of both ventricles without a LVOT obstruction in the mid-esophageal 5-chamber view (Fig. 2A, Video 1A, <http://links.lww.com/MD/B204>). Because the decreased blood pressure persisted, 10 mcg epinephrine, the treatment of choice for PRS, was injected twice intravenously. However, the patient's blood pressure did not increase, and the SvO_2 decreased. We were about to provide an incremental dose of epinephrine, as usually done, because we believed that the initial amount was not sufficient to overcome PRS. Surprisingly however, the TEE indicated a hypovolemic and hyperdynamic left ventricle along with SAM of the mitral valve leaflets that led to an obstruction of the LVOT (Fig. 2B, Video 1B, <http://links.lww.com/MD/B204>). A moderate degree of mitral valve regurgitation was also found in the color Doppler mode (Fig. 2C, Video 1C, <http://links.lww.com/MD/B204>). Therefore, 100 mcg phenylephrine was injected along with an intravenous fluid bolus to increase the intraventricular

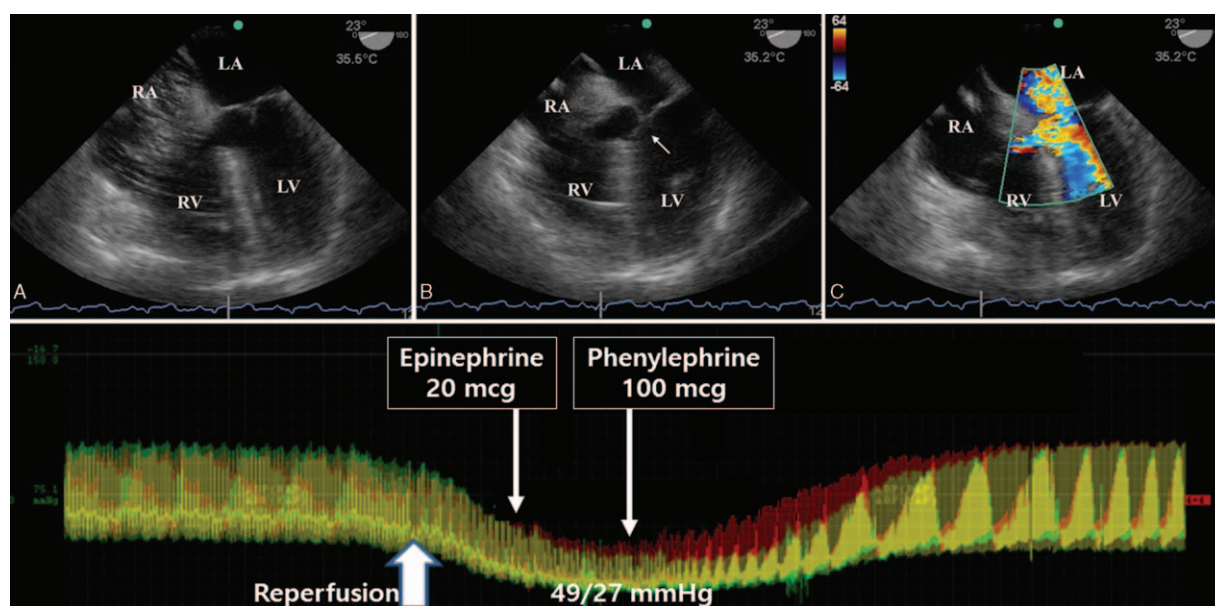


Figure 2. A mid-esophageal 5-chamber view of transesophageal echocardiography during the reperfusion period in the study patient is shown. Shortly after reperfusion, air bubbles rushed into the right atrium from the inferior vena cava (A). After administration of 20 mcg of epinephrine, a dynamic left ventricular outflow tract obstruction occurred with systolic anterior motion of the mitral valve leaflets (white arrow) (B). In the color Doppler mode, high-velocity turbulent flow through the left ventricular outflow tract and a mitral regurgitation jet were observed (C). LA=left atrium, LV=left ventricle, RA=right atrium, RV=right ventricle.

volume and afterload. Soon after, the blood pressure and SvO₂ were rapidly restored to within the normal range. The LVOT obstruction with SAM of the mitral valve leaflets and mitral valve regurgitation resolved simultaneously.

After the patient's vital signs were stabilized, we reviewed the preoperative TTE and intraoperative TEE. These scans showed that the thickened end-diastolic basal interventricular septum had protruded into the LVOT, which was not mentioned in the preoperative TTE (Fig. 1). The patient had a prominent "knuckle" of the end-diastolic basal interventricular septum (18 mm) (Fig. 2B), and the LVOT was angulated. The angle measured between the basal portion of interventricular septum and the ascending aorta was 93°, which was far less than the normal range (145 ± 7°). With the features mentioned above, the diagnosis of an SVS could be established. During the neohepatic phase, no further adverse events occurred. The patient was transferred to the intensive care unit and extubated on postoperative day 1. Three days later, a follow-up TTE was performed showing no change in the SVS without any obstruction. The patient recovered and was discharged on postoperative day 26.

3. Discussion

Our present case clearly showed that anesthetic management of a patient with an SVS during LT surgery can be complicated by the potential risk of an LVOT obstruction, especially during the reperfusion period. Although dynamic LVOT obstruction has been reported in patients with an SVS,^[3,5,6,9,10] our present report is the first to document this phenomenon during LT.

Because of unique hemodynamic and cardiac morphological characteristics, elderly patients with end-stage liver disease are highly susceptible for developing LVOT obstruction. After reperfusion of the graft, LT recipients often encounter severe hemodynamic instability, the so-called PRS. This instability can

present as a decrease in systemic vascular resistance (SVR) and relative hypovolemia or sometimes can be accompanied by decreased contractility of both ventricles. In these situations, the treatment of choice is epinephrine, a nonselective adrenergic agonist that can be effective in both circumstances. However, as in our present case, further hemodynamic instability develops with epinephrine treatment in patients with an SVS. Strong inotropic and chronotropic effects by epinephrine in conjunction with low SVR and relative hypovolemia because of PRS can exacerbate a dynamic LVOT obstruction.^[8,11] Thus, an early differential diagnosis of prolonged PRS is important, and patient management should be differentiated according to this diagnosis.

In our present case, TEE played a crucial role in both the early recognition and management of a dynamic LVOT obstruction caused by SAM of the mitral valve leaflets. Because TEE was continuously monitored during the reperfusion period in our patient, the dynamic LVOT obstruction could be recognized instantly. Also, appropriate management could be initiated with phenylephrine and fluid loading rather than treatment with additional epinephrine that may have resulted in fatal consequences. Unlike numeric data obtained from the blood pressure waveform, TEE permits an instant and direct assessment of both structural and dynamic functions of the heart.^[12,13] Moreover, TEE has been reported to be relatively safe, as it showed low incidence of hemorrhagic complication despite the presence of esophageal varices.^[14,15] Therefore, TEE should always be considered for patients with prolonged PRS, especially for patients with a high risk of developing an LVOT obstruction.^[16,17]

Although the underlying mechanism for a dynamic LVOT obstruction in an SVS case has not been well-established, it is believed that this mechanism is similar to that for hypertrophic cardiomyopathy.^[9] The angulation of the LVOT alters flow vectors in the left ventricular cavity, and protrusion of the basal septum causes flow acceleration around the narrowed LVOT.

The “drag effect” and “Venturi effect,” respectively, are thought to involve SAM of the mitral valve leaflets in patients with an SVS developing a dynamic LVOT obstruction.^[6,9] A recent review by Hymel and Townsley^[16] summarized several characteristic echocardiographic features for predicting SAM of the mitral valve leaflets. These include a basal interventricular septal thickness >15 mm, a C-sept distance (distance from the mitral coaptation point to the septum) <25 mm, a mitral-aortic angle (angle formed by the intersection of the mitral annulus and aortic annulus) <120°, and an abnormal mitral leaflet length. Another study by Tano et al^[3] showed that a short end-systolic leaflet tethering distance (the distance between the tip of the posterior papillary muscle and the contralateral anterior part of the mitral annulus) in the resting state was a major determinant for developing an LVOT obstruction with SAM of the mitral valve leaflets in patients with an SVS during a dobutamine provocation test (29.9 ± 4.2 vs 35.2 ± 4.6 mm). Our present case satisfied most of these provocative conditions. Our present patient had an 18-mm end-diastolic basal interventricular thickness, a 20-mm C-sept distance, and a 32-mm leaflet tethering distance. The angle measured between the basal septum and ascending aorta was 93° and the mitral-aortic angle was 102° (Fig. 1).

There has been previous case report of an SVS with a LVOT obstruction during surgery.^[10] In that patient, a low SVR caused by spinal anesthesia provoked a dynamic LVOT obstruction. In other previous case reports, dynamic LVOT obstructions were provoked in certain hemodynamic settings such as a dobutamine stress test, exercise test, or administration of a phosphodiesterase 3 inhibitor.^[3,6] These settings are all associated with increased contractility and a decreased SVR. During LT surgery, recipients undergo a similar but usually more aggravated hemodynamic derangement during graft reperfusion. For this reason, anesthesiologists should keep in mind that a dynamic LVOT obstruction may occur during LT surgery even in patients with a less severe form of SVS. Moreover, whenever refractory hemodynamic instability occurs in circumstances with increasing contractility and decreasing SVR, an undiagnosed SVS should always be suspected as a hidden cause.

In summary, we here report the first case of a dynamic LVOT obstruction arising at the graft reperfusion period of LT surgery in a patient with an SVS. Dynamic LVOT obstruction should always be considered as a possible cause for hemodynamic instability during the reperfusion period, especially in elderly patients with an SVS. In addition, TEE is a very useful tool for both the diagnosis of hemodynamic derangements and the guidance for appropriate management during LT surgery. The routine use of TEE is therefore highly recommended.

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