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Difficult Anesthesia Management in a Case of Living Donor Liver Transplantation with Hypertrophic Obstructive Cardiomyopathy

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ABSTRACT

Liver transplantation with hypertrophic obstructive cardiomyopathy is associated with acute hemodynamic changes, which can exacerbate left ventricular outflow tract obstruction during surgery. Therefore, selection of general anesthetic agents is important, as most can result in hemodynamic instability by reducing systemic vascular resistance and blood pressure. We report successful anesthetic management in a case of living donor liver transplantation with hypertrophic obstructive cardiomyopathy using ketamine, propofol, and fentanyl to avoid vasodilation by anesthetic agents. In addition, landiolol, phenylephrine, and low-dose dopamine were administered to prevent left ventricular outflow tract obstruction, and were found to be effective for improving acute hemodynamic changes during surgery. In the case of this patient, the combination of transesophageal echocardiography and a pulmonary artery catheter was beneficial for intraoperative hemodynamic monitoring.

Key words: *Liver transplantation, Hypertrophic obstructive cardiomyopathy, General anesthesia*

Hypertrophic obstructive cardiomyopathy (HOCM) is characterized by a dynamic left ventricular outflow tract (LVOT) obstruction caused by asymmetrical septal hypertrophy and systolic anterior motion (SAM) of the mitral valve[6]. The surgical procedures associated with liver transplantation can cause acute hemodynamic changes, which may exacerbate LVOT obstruction during the operation. Moreover, anesthetic agents can also exacerbate LVOT obstruction by reducing systemic vascular resistance. Although careful anesthetic management is needed for liver transplantation in a patient with HOCM, no optimal anesthetic strategy has been documented. Here, we report successful anesthetic management in a case of living donor liver transplantation with HOCM.

CASE DESCRIPTION

A 57-year-old male (height 168 cm, weight 72 kg) with a hepatic cell carcinoma and end-stage HCV-related liver cirrhosis was scheduled for living donor liver transplantation. Although he underwent a partial hepatectomy and transarterial anticancer drug infusion, his liver function gradually deteriorated, along with progression of portal hypertension in one year. Blood examination showed a decrease in the number of platelets (71 $\times 10^3/\mu l$) and mild coagulopathy (international normalized ratio 1.5 and activated partial thromboplastin time 35 sec). Preoperative esophagogastroduodenoscopy showed a mild degree of esophagogastric varices which required no treatment. Preoperative echocardiogram findings revealed an LVOT obstruction (resting pressure gradient 120 mmHg), asymmetrical septal hypertrophy, SAM of the mitral valve, and moderate mitral regurgitation (MR). As a result, he was diagnosed with HOCM. Preoperative oral administration of an antiarrhythmic agent, cibenzoline, and the beta-blocker bisoprolol decreased the resting left ventricular outflow tract gradient (LVOTG) to 32 mmHg, while MR and SAM remained. Cardiac catheterization revealed an intact coronary artery, while continuous dobutamine infusion at more than 5 μg/kg/min increased LVOTG, resulting in hypotension. In

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addition, dopamine stress echocardiography showed an increase in LVOTG with a dosing rate greater than 15 μg/kg/min.

The time course of surgery is shown in Fig. 1. General anesthesia was induced with fentanyl (100 μg), ketamine (50 mg), and propofol (50 mg), then endotracheal intubation was facilitated by administration of vecuronium (0.1 mg/kg). Anesthesia was maintained with total intravenous anesthesia, including fentanyl (200 μg/hr), ketamine (0.5 mg/kg/hr), propofol (2 mg/kg/hr), and vecuronium (2 mg/hr). Following induction of anesthesia, monitoring with transesophageal echocardiography (TEE) was commenced and a pulmonary artery catheter (PAC) was inserted via the right internal jugular vein. In the initial measurements obtained with the PAC following induction of general anesthesia, central venous pressure (CVP) was 9 mmHg, pulmonary artery pressure (PAP) was 27/14 mmHg, SvO_2 was 72%, and cardiac index was 2.7 liters/min/m^2. Baseline TEE showed trivial MR, while LVOTG was 12 mmHg and left ventricular diastolic dimension (LVDd) was 42 mm. Continuous infusion of phenylephrine at a dosage of 0.1 μg/kg/min was started to avoid hypotension and LVOT obstruction soon after induction. During the pre-anhepatic phase, blood pressure (BP) decreased to 65/30 mmHg and LVOTG increased to 64 mmHg following surgical bleeding. Thus the continuous phenylephrine infusion was increased to 2 μg/kg/min, and dopamine and landiolol were started at 3.5 μg/kg/min and 20 mg/hr, respectively, in addition to volume replacement. Thirty minutes after administration of dopamine and landiolol, BP increased to 100/50 mmHg and LVOTG decreased to 34 mmHg. There was no hemodynamic instability related to the performance of a Pringle maneuver, i.e., clamping of the portal vein, hepatic artery, and hepatic vein. During the anhepatic phase there was no remarkable change in hemodynamic status, while prior to reperfusion to the graft liver BP and PAP were 115/60 and 25/17 mmHg, respectively. With reperfusion, BP decreased to 70/35 mmHg and PAP increased to 36/19 mmHg, while TEE showed an increase in LVOTG (64 mmHg) and a decrease in LVDd. Thus extra fluids and multiple additional bolus administrations of phenylephrine were given. Within 10 min, BP increased to the same level as before the reperfusion and LVOTG gradually decreased to 22 mmHg, while SvO_2 and cardiac output remained unchanged during this period. Subsequently, intraoperative hemodynamic status was stable and landiolol infusion was discontinued at the end of surgery, after which the patient was transferred to the ICU. Continuous administration of phenylephrine was continued until the first postoperative day. The postoperative course was uneventful, and he was extubated on postoperative day 2 and discharged from the ICU on postoperative day 4.

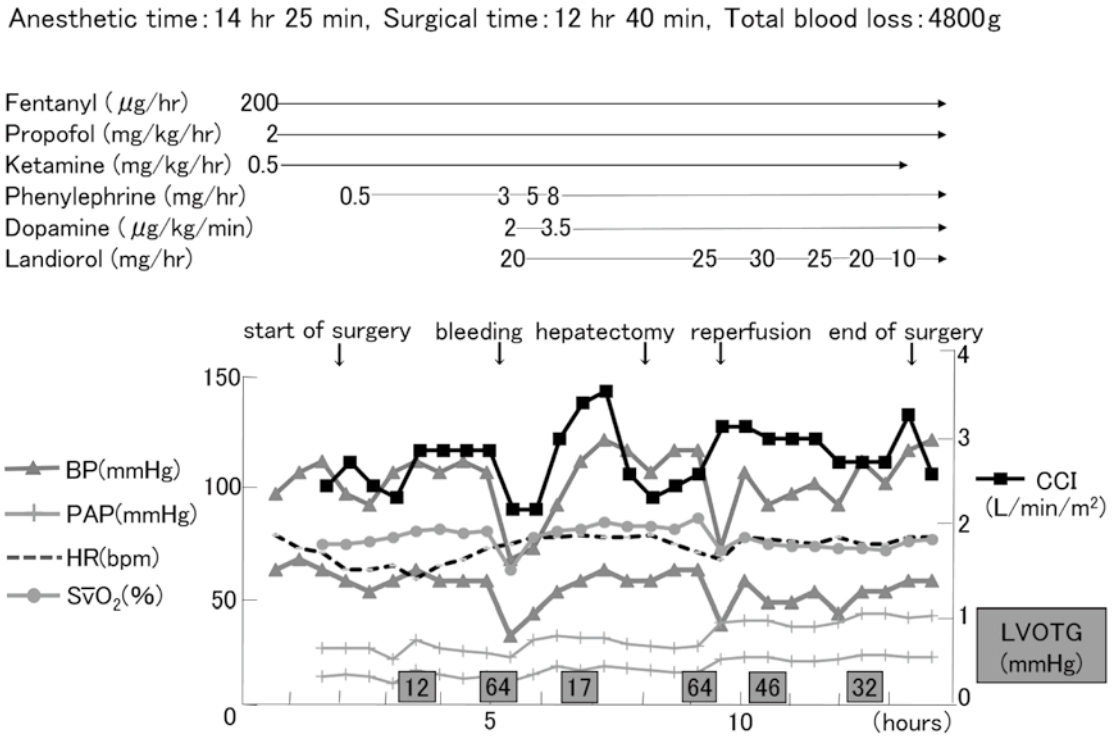

Fig. 1. Time course during surgery.

DISCUSSION

Although the majority of patients with HOCM are asymptomatic, some present cardiac adverse events including critical arrhythmia and myocardial ischemia with LVOT obstruction in the perioperative period[2,6,7]. LVOT obstruction is exacerbated by reduced intraventricular volume, hyper-contraction, tachycardia, reduced systemic vascular resistance (SVR), and positive inotrope administration. Therefore, anesthetic management requires the preservation of preload and afterload, control of cardiac contraction and heart rate, and adequate use of anesthetics[9]. In addition, the selection of general anesthetics is an important issue, because most agents can result in hemodynamic instability by reducing systemic vascular resistance and blood pressure. However, patients with liver cirrhosis have a high cardiac output, low SVR, and a high risk of massive bleeding due to developing extrahepatic collateral flow and coagulopathy. Moreover, the surgical procedure for liver transplantation is associated with acute changes of hemodynamics from the removal of massive ascites fluid, significant blood loss, clamping of large vessels, and reperfusion to the graft liver. Each may exacerbate LVOT obstruction, resulting in circulatory collapse, indicating that careful anesthetic management is required during liver transplantation in patients with HOCM[3,5].

In the present case, we selected total intravenous anesthesia using fentanyl, propofol, and ketamine to avoid peripheral vasodilation and tachycardia. Yamaguchi et al reported that anesthetic management with fentanyl, propofol, and ketamine provided hemodynamic stability for a patient with HOCM[12]. Although propofol has cardiodepressive and vasodilative effects, these may be counterbalanced by the cardio-stimulant effect of ketamine. Hui et al noted that the combination of propofol and ketamine for anesthesia induction improved cardiovascular stability when compared with either agent administered alone[4]. We observed no significant change in hemodynamic status during anesthesia induction and maintenance in our patient.

Although alpha-stimulants are often used to maintain afterload during surgery for patients with HOCM[5], we maintained continuous administration of phenylephrine after anesthesia induction in the present case. Phenylephrine can increase splanchnic oxygen extraction and the mixed venous-hepatic vein oxygen saturation gradient[8], which may increase the liver oxygen demand-supply relationship. Therefore, phenylephrine should be discontinued as soon as possible after reperfusion of the graft liver during liver transplantation. We then adjusted the dosage and continued administration until the first postoperative day based on the hemodynamics and postoperative liver perfusion shown by abdominal ultrasonography. We consider that the use of alpha-stimulants is acceptable when organ perfusion is closely monitored.

We also used landiolol, a short-acting cardioselective beta-blocker, and low-dose dopamine in addition to volume replacement against hypotension and LVOTG increase following operative blood loss. A beta-blocker is often used for treatment of HOCM patients, because it relaxes LVOT stenosis and reduces LVOTG by its negative inotropic effect without vasodilation[11]. In the present patient, landiolol was continuously administered and the dosage was controlled according to the LVOTG measured by TEE. We consider that landiolol can be safely used to improve increased LVOTG accompanied by hypotension because it can decrease heart rate without affecting blood pressure[13].

Although the use of positive inotropic drugs in HOCM patients should be avoided for exacerbation of LVOT stenosis, we administered dopamine during the perioperative period. We controlled the dosage to not greater than 3.5 μg/kg/min according to preoperative dopamine stress echocardiogram findings and intraoperative LVOTG measured by TEE. We avoided the use of dobutamine because low-dose dobutamine administration increased LVOTG and resulted in hypotension in preoperative dobutamine stress cardiac catheterization. Consequently, dopamine administration did not increase LVOTG and resulted in hemodynamic stability. We consider that low-dose dopamine administration is permissible for a short period with precise preoperative and intraoperative evaluations.

When evaluating hemodynamic status in liver transplantation cases, PAC is sometimes unreliable, because the thermal dilution cardiac output measurement does not remain accurate for the period of clamping the large vessels and reperfusion to the graft liver, during which rapid hemodynamic changes can occur and cold Ringer's solution from the graft liver enters the systemic circulation. In addition, pulmonary artery pressure increases due to MR in HOCM patients, making interpretation of preload using PAC difficult. On the other hand, TEE can visualize the preload parameters, left ventricular diastolic diameter, and ventricular wall motion. Especially in HOCM patients, evaluation of LVOT obstruction and MR due to SAM with TEE is valuable for operative circulatory management[10]. However, it is difficult to use TEE continuously during the operation, whereas PAC can function constantly and also provide other parameters of peripheral perfusion, such as SvO_2 and SVR. We therefore consider that the combined use of TEE and PAC is

preferable for evaluation of hemodynamic status in liver transplantation. In addition, the use of TEE for patients with liver disease has a high risk of gastroesophageal complications due to varices secondary to portal hypertension. On the other hand, Burger-Klepp et al showed that intraoperative TEE can be performed relatively safely in patients undergoing liver transplantation with esophagogastric varices[1]. In the present patient, there were no esophagogastric varices that required treatment or history of esophagogastric bleeding. Thus, it was possible to use TEE with careful attention during the operative period.

In summary, we were able to manage living donor liver transplantation in a patient with HOCM without complications by use of total intravenous anesthesia with ketamine, propofol, and fentanyl to maintain hemodynamic stability. In addition, landiolol, phenylephrine, and low-dose dopamine were administered to prevent LVOT obstruction, and were found to be effective for improving acute hemodynamic changes during surgery. The combination of TEE and PAC was beneficial for intraoperative hemodynamic monitoring. Our strategy is considered to be useful and applicable for anesthesia management in patients with HOCM undergoing liver transplantation.

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