Orthotopic liver transplantation in two patients with hypertrophic obstructive cardiomyopathy

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Summary

Orthotopic liver transplantation (OLT) in patients with end-stage liver disease is a procedure associated with high cardiac output, low systemic vascular resistance (SVR), coagulopathy and the potential for significant blood loss. A feature of hypertrophic obstructive cardiomyopathy (HOCM) is left ventricular outflow tract obstruction which may be exacerbated by reduced SVR, reduced filling pressures, tachycardia and positive inotropy. We report two cases of OLT in patients with HOCM. Our anaesthetic technique involved the use of halothane and vecuronium and avoidance of drugs causing tachycardia and positive inotropy. Management was aided by intraoperative transoesophageal echocardiography which showed that filling pressures poorly reflected end-diastolic volumes. Volume administration, vasoconstrictors and avoidance of inotropes and chronotropes reduced the outflow tract obstruction which was particularly severe in the reperfusion period. (*Br. J. Anaesth*. 1996; **77**: 675–677)

Key words

Monitoring, echocardiography. Surgery, hepatic. Liver, transplantation. Complications, hypertrophic obstructive cardiomyopathy.

Case reports

CASE NO. 1

The patient was a 46-yr-old male with end-stage alcoholic liver disease. He had portal hypertension with severe ascites, oesophageal varices and impaired renal function. Clotting function tests showed mild coagulopathy (international normalized ratio (INR) 1.5). Preoperative transoesophageal echocardiography (TOE) was performed to evaluate a murmur heard on physical examination. It showed asymmetrical septal hypertrophy, systolic anterior motion (SAM) of the mitral valve with normal mitral morphology, mild mitral regurgitation (MR) and left ventricular outflow tract (LVOT) obstruction, and a resting gradient 36 mm Hg (fig. 1) and thus a diagnosis of hypertrophic obstructive cardiomyopathy (HOCM) was made. After nitrate provocation there

was increased SAM, severe MR and an LVOT gradient of 64 mm Hg.

Anaesthesia was induced with fentanyl 6 μg kg^{-1} and thiopentone 100 mg and maintained with fentanyl 3 μg kg^{-1} h^{-1} and halothane in air and oxygen. Neuromuscular block was produced with vecuronium. Monitoring included an oximetric pulmonary artery catheter and TOE. During liver resection a baseline TOE was performed and fluid challenges were given to assess changes in left ventricular (LV) dimensions. Full cardiopulmonary bypass with heparin-bonded tubing was on standby.

Haemodynamic variables at various times are shown in table 1.

During the anhepatic stage the patient developed a low systemic vascular resistance index (SVRI) and increased cardiac index (CI). Fibrinolysis was demonstrated by a decrease in euglobulin clot lysis time and fibrinogen concentration, and 7 litre of blood were lost over 120 min. An infusion of phenylephrine was commenced and fluid was replaced according to LV dimensions on TOE rather than pulmonary capillary wedge pressure (PCWP). Veno–venous bypass (femoro–portal to axillary vein) was used electively during the anastomosis of the new liver.

On reperfusion the patient developed severe reperfusion syndrome. He also developed a severe coagulopathy and another 15 litre of blood was lost in the first hour after reperfusion. Total intraoperative blood loss was 42 litre. Vasodilatation and blood loss were associated with an increase in the severity of the LVOT obstruction measured on TOE. TOE also showed a relatively empty LV with dynamic systolic function (in spite of a PCWP of 30 mm Hg), increased SAM, severe LVOT obstruction (maximum measured gradient 120 mm Hg) and severe MR. This was treated with aggressive volume replacement and infusion of phenylephrine. Inotropes were avoided.
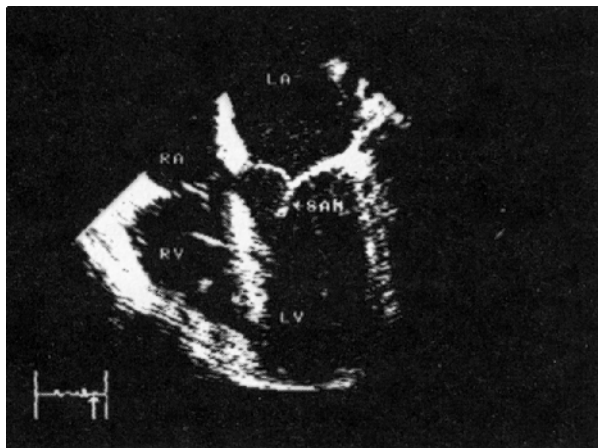
In the 3 h after reperfusion the degree of outflow obstruction reduced gradually as SVRI increased. His postoperative course was relatively uneventful and he was well 18 months after transplant.

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Table 1 Haemodynamic variables at five times during operation. III-5 = 5 min before reperfusion during the anhepatic phase, III + 5 = 5 min after reperfusion, III + 60 = 60 min after reperfusion, and III + 180 = 180 min after reperfusion

Stage	Heart rate (beat min^{-1})	MAP (mm Hg)	CI (litre min^{-1} m^{-2})	SVRI (dyn s m^{-2} cm^{-5})	PCWP (mm Hg)
Patient 1					
Baseline	98	74	4.4	1239	10
III-5	86	57	5.3	840	12
III+5	86	49	6.8	460	20
III+60	106	56	6.8	538	30
III+180	116	61	5.7	736	15
Patient 2					
Baseline	95	68	8.4	560	16
III-5	114	76	9.7	530	13
III+5	115	69	12.0	346	23
III+60	107	70	10.6	474	24
III+180	114	76	9.5	541	16

Figure 1 Patient No. 1. Transoesophageal four-chamber view showing septal hypertrophy and systolic anterior motion of the mitral valve. LA = Left atrium, LV = left ventricle, RA = right atrium, RV = right ventricle, SAM = systolic anterior motion of the mitral valve.
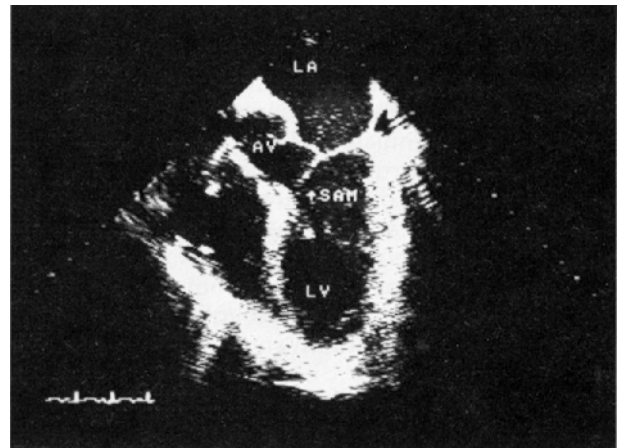
Figure 2 Patient No. 2. Transoesophageal modified four-chamber view showing small left ventricular cavity, severe systolic anterior motion of the mitral valve and almost complete obliteration of the left ventricular outflow tract (peak gradient 120 mm Hg). This was accompanied by severe mitral regurgitation on colour flow Doppler (not shown). AV = Aortic valve. Other abbreviations as in figure 1.

CASE NO. 2

The patient was a 32-yr-old female with a 16-yr history of autoimmune chronic active hepatitis. She was jaundiced, markedly cushingoid and had severe hepato-pulmonary syndrome with cyanosis and clubbing. She was an insulin-dependent diabetic secondary to steroid administration. Her renal function was normal and preoperative clotting tests showed mild coagulopathy (INR 2.0). She had a murmur but no symptoms of HOCM. Preoperative transthoracic echocardiography and TOE demonstrated severe concentric left ventricular hypertrophy, normal mitral morphology and mild SAM associated with moderate MR and an LVOT gradient of 60 mm Hg without provocation.

Anaesthesia was induced with thiopentone 250 mg and fentanyl 8 μg kg^{-1} and maintained with fentanyl 3 μg kg^{-1} h^{-1} and halothane in air and oxygen. Neuromuscular block was produced with vecuronium. Monitoring included TOE and an oximetric pulmonary artery catheter. After induction of anaesthesia, derived cardiac indices showed a hyperdynamic circulation (see table 1). However, TOE showed only mild to moderate SAM and MR and the LVOT gradient was only 12 mm Hg. Cardiac output was maintained during a 5-min trial of inferior vena cava (IVC) occlusion and therefore a decision was made to perform the proximal anastomosis without bypass. The IVC was cross-clamped for 13 min in total. Later in the anhepatic stage, TOE showed mild SAM, mild MR but an increasingly hyperdynamic left ventricle with worsening LVOT obstruction. SVRI decreased from 900 to 530 dyn s m^2 cm^{-5}. An infusion of phenylephrine was therefore started and extra fluids were given in addition to replacement of minimal blood loss.

With reperfusion SVRI decreased to 346 dyn s m^2 cm^{-5}. Transoesophageal echocardiography showed development of marked SAM with severe MR and LV cavity obliteration during systole (fig. 2) The maximal LVOT gradient measured was 64 mm Hg. Multiple boluses and increasing rates of infusion of phenylephrine were administered. Washed donor red cells (600 ml) and Haemaccel 1 litre were infused in the first 30 min after reperfusion, despite minimal blood loss, in an attempt to increase ventricular volumes and reduce LV systolic obliteration as seen on TOE. PCWP increased to 24 mm Hg and CI increased to 10.61 min^{-1} m^{-2} but LV obliteration and outflow tract obstruction changed little.

Slowly over 2 h LVOT obstruction and MR and SAM resolved to levels similar to those in the pre-anhepatic stage. One hour after reperfusion an infusion of prostaglandin E_1 (PGE_1) 10 μg h^{-1} was started, slowly increasing to 30 μg h^{-1} as the patient's vasodilatation allowed.

The patient's postoperative course was complicated only by minor sepsis and transient pancytopenia. She was well 1 yr after transplant and her hepato–pulmonary syndrome is resolving.

Discussion

Hypertrophic cardiomyopathy (HCM) is inappropriate myocardial hypertrophy often involving the septum of a non-dilated left ventricle. HOCM is a subset of HCM in which the hypertrophy causes LVOT obstruction. It is an autosomal dominant condition with variable penetrance.[1]

The features of HOCM are a hypercontractile left ventricle, diastolic dysfunction, a high ejection fraction and systolic anterior motion of the mitral valve with or without mitral regurgitation. The obstruction is dynamic in that it changes depending on preload, afterload, sympathetic activity and posture.

The symptoms of HOCM range from none to dyspnoea, syncope, palpitations, chest pain and sudden death. Signs include a jerky pulse, fourth heart sound and an early to mid-systolic murmur increasing with a Valsalva manoeuvre. Diagnosis is usually confirmed by echocardiography.

The problems of providing anaesthesia to a patient with HOCM are exacerbated in liver transplantation. Patients with liver disease tend to have a low systemic vascular resistance and liver transplantation is associated with further vasodilatation, the potential for significant blood loss and occasionally the need for inotropes around the time of reperfusion. All of these factors exacerbate the haemodynamic disturbances of HOCM, which benefits from high afterload and preload, a relatively low heart rate and negative inotropy. Diastolic function is markedly impaired in HOCM and delayed isovolumetric relaxation reduces early diastolic filling.[2 3] There is an increased reliance on atrial contraction, diastolic filling pressures and adequate duration of diastolic filling.[4]

We chose an anaesthetic technique that avoided drugs such as isoflurane and pancuronium which cause vasodilatation and tachycardia and instead used halothane and vecuronium. We used phenylephrine for vasoconstriction as it has no inotropic or chronotropic effect. Our unit routinely administers PGE_1 to all liver transplant patients in the post-reperfusion period to increase hepatic blood flow and for its presumed cytoprotective effect. In case No. 1 we were unable to begin PGE_1 infusion, a potent vasodilator, until the patient had returned to the ICU, because of his extreme peripheral vasodilatation. In case No. 2 the patient tolerated only a very slow increase in the infusion rate to 30 μg h^{-1} in theatre.

Transoesophageal echocardiography played a very important role in the intraoperative management of both patients. The measured haemodynamics of high PCWP and low mean arterial pressure, especially in the post-reperfusion period, may have prompted the use of inotropic agents with their potentially deleterious effects. However, TOE demonstrated low ventricular volumes despite a high PCWP and management was therefore with additional fluids and a direct acting vasopressor (phenylephrine). It has been shown during OLT that TOE has a better correlation with ventricular volumes than does PCWP.[5-8] In this case we found TOE to be the most useful guide to fluid management, especially in the post-reperfusion period.

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