
Case report - Cardiac general
Successful aortic valve replacement using dilutional ultrafiltration during cardiopulmonary bypass in a patient with Child-Pugh class C cirrhosis

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Abstract
Open-heart surgery is a relatively high-risk procedure when performed in patients with Child-Pugh class C cirrhosis. Even though they can tolerate cardiac surgery with cardiopulmonary bypass (CPB), most of them suffer major postoperative complications and prolonged hospital stay. The present report describes a case of a patient with Child-Pugh class C cirrhosis who developed severe heart failure secondary to aortic valve stenosis. The patient underwent successful aortic valve replacement with the use of dilutional ultrafiltration during CPB to reduce adverse effects of CPB. He recovered smoothly after the operation without major postoperative complications. Thus, the use of dilutional ultrafiltration (DUF) during CPB appears to produce beneficial effects for improving outcomes in patients with decompensated cirrhosis who require open-heart surgery.

Keywords: Ultrafiltration; Cirrhosis; Open-heart surgery

1. Introduction
The presence of severe liver dysfunction with cirrhosis poses considerable challenges in patients undergoing cardiac surgery with cardiopulmonary bypass (CPB) and is associated with relatively high rates of morbidity and mortality [1, 2]. Thus, cardiac surgery with CPB is generally contraindicated in patients with severe cirrhosis unless there is an urgent indication that is not otherwise responsive to medical therapy.

The present study describes a case of a patient with chronic cirrhosis (Child-Pugh class C) and hepatic encephalopathy who underwent successful aortic valve replacement (AVR) with dilutional ultrafiltration during CPB for management of severe aortic valve stenosis without major postoperative complications.

2. Case report
In October 2001, a 64-year-old man with chronic hepatic C liver disease underwent variceal ligation for esophageal variceal rupture. In March 2003, the patient was diagnosed with aortic valve stenosis. In November 2006, despite medical therapy, the patient was admitted to our hospital for surgical treatment secondary to aortic valve severe stenosis and progressive heart failure. On admission, the now 69-year-old man had NYHA class 3 dyspnea and grade 3 hepatic encephalopathy. Echocardiogram demonstrated severe aortic valve stenosis and grade 2 aortic regurgitation, a LVDd of 64 mm, a LVDs of 54 mm, and a left ventricular ejection fraction of 33%. Abdominal ultrasound demonstrated mild ascites. Laboratory testing showed a marked increase in BNP and severe liver dysfunction and thrombocytopenia and hyperammonemia (Table 1). Taken together, these data were consistent with a diagnosis of severe heart failure and chronic severe cirrhosis (Child-Pugh class C). Medical treatment with catecholamines and a phosphodiesterase-3 inhibitor was initially attempted for heart failure, and ammonia levels were controlled using cathartics, antibiotics, and by limiting protein intake. After achieving a state of general medical stability, AVR was performed on the 15th day of his hospitalization.

Surgery was performed via a median sternotomy. CPB was instituted between the ascending aorta and both vena cavae. The priming solution contained packed red blood cells, 25% albumin, mannitol (300 ml), NaHCO3, bicarbonate-Ringer’s solution, and aprotinin (500,000 KIU). Myocardial preservation was achieved through both antegrade and retrograde administration of BuckBurg blood cardioplegia solution. Before bypass was started, heparin sodium was administered at an initial dose of 300 IU/kg. Additional heparin was administered if the activating clotting time fell below 500 s. The ascending aorta was clamped, and cold cardioplegic solution was infused. The heart arrested, and the ascending aorta was opened, showing bicuspid aortic valve with severe aortic annular calcification. The calcified aortic valve was removed and replaced with a...
bioprosthetic valve [21 mm, Medtronic Mosaic (Medtronic, Minneapolis, MN) bioprosthesis]. During CPB, the hematocrit was maintained between 18 and 25%, perfusion flow was maintained between 2.5 and 2.8 l·min⁻¹·m⁻², mean arterial pressure was maintained between 50 and 70 mmHg, and systemic temperature was maintained between 31 and 34 °C. Dilutional ultrafiltration (DUF) was initiated during CPB and maintained for as long as possible during CPB. A polyether sulfone ultrafilter (Aquadstream, JMS, Hiroshima, Japan) was used for ultrafiltration. The operation proceeded uneventfully with a CPB time of 126 min and an aortic clamp time of 64 min. The total ultrafiltered volume was 6000 ml with a final operative water balance of −1100 ml. After discontinuation of CPB, 40 U of platelet concentrate was administered.

The total operative blood loss was 870 ml. The duration of postoperative mechanical ventilation was 10 h. The patient recovered well after an uneventful postoperative course. Ten months after surgery, the patient remained well without limitations in his activities of daily living.

### 3. Discussion

Previous studies suggest that utilization of cardiac surgery with CPB in patients with decompensated cirrhosis results in high rates of morbidity and mortality. Several studies reported that patients with advanced cirrhosis had a mortality rate of 50–100%, and a major complication rate of 89–100% [1–3], while another study reported a 100% major complication and mortality rate in patients with Child-Pugh class C cirrhosis undergoing cardiac surgery with CPB [4]. Based on these results, elective cardiac operation using CPB is generally considered as contraindicated in patients with severe cirrhosis (Child-Pugh class C cirrhosis). Mean while, it was also reported that patients with advanced cirrhosis can tolerate coronary artery bypass grafting without CPB satisfactorily [4]. On the basis of these reports, to minimize adverse effects of CPB may play a key role in improvement of postoperative clinical outcome, particularly in patients with advanced cirrhosis.

In patients with advanced cirrhosis, CPB triggers the production and release of numerous vasoactive substances and cytotoxic chemicals that affect coagulation, vascular resistance, vascular permeability, and fluid balance [4], all of which can increase the risk of postoperative complications, including mediastinal bleeding, gastrointestinal disorders, hepatic and renal failure, and fluid retention manifesting as edema, ascites, pericardial effusion, and pleural effusion [5]. Optimization of preoperative hepatic status and use of the most effective pharmacologic and technical measures such as maintenance of hepatic blood flow in the perioperative period and administration of increased amounts of platelet concentrate and fresh frozen plasma minimizes the adverse effect of CPB in patients with decompensated cirrhosis [1, 4]. However, only these measures were not considered to be sufficient in the present case.

The use of DUF or modified ultrafiltration (MUF) in patients undergoing CPB has several beneficial effects to reduce adverse effects of CPB. First, they help maintain serum protein and hematocrit levels by reversing the effects of CPB-induced hemodilution. Second, they remove chemical mediators formed during the use of CPB, thereby attenuating capillary leakage and tissue edema after CPB [5–7]. These techniques add no risk to the operation. Therefore, patients with advanced cirrhosis could be good candidates for DUF or MUF. However, MUF requires an additional circuit and extra time after CPB cessation. Our reason for using DUF was to remove inflammatory mediators and to reduce tissue edema and organ dysfunction without additional perfusion time.

In conclusion, the use of DUF during CPB appears to produce beneficial effects for improving outcomes in patients with decompensated cirrhosis who require open-heart surgery.

### References