

Treatment of Refractory Coronary Vasospasm during Cardiopulmonary Bypass with Compulsory Coronary Perfusion

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Coronary vasospasm is still a devastating complication during cardiac surgery. We report on a case of intractable coronary vasospasm in a 45-year-old male during coronary bypass surgery refractory to drugs and intra-aortic balloon pumping (IABP). Under cardiopulmonary bypass (CPB) support, the aorta was again cross-clamped and the aortic root was compulsorily perfused with pump blood using a small pump for infusion of cardioplegia. Vasodilators were administered through the perfusion line. Coronary vasospasm was dramatically resolved. He was then successfully weaned from CPB and recovered without further incidents. (Ann Thorac Cardiovasc Surg 2002; 8: 386-8)

Key words: coronary spasm, CABG

Introduction

Intra-operative coronary spasm sometimes leads to difficulty in weaning from cardiopulmonary bypass (CPB), or sudden circulatory collapse. Intravenous or intra-coronary administration of vasodilators is usually effective for the treatment.¹⁾ However, we experienced a case of severe coronary spasm during CPB who did not respond to all the usual treatment. We managed to solve the problem and report herein the details.

Case

A 45-year-old male was referred to our institution with a diagnosis of unstable angina with a left main coronary lesion. His height was 170 cm and body weight was 85 kg. The electrocardiogram (ECG) at rest was within normal limits. The chest roentgenogram was normal with 47% of CTR. The coronary angiogram showed tandem 90% stenoses in the left main trunk (LMT) and 90% steno-

sis in the high lateral branch. The left ventriculogram showed slight decrease of wall motion in the anterior wall. The right coronary was dominant and the circumflex branches were hypoplastic.

Coronary bypass surgery was performed in April 2001. High dose fentanyl was used for anesthesia. As the routine regimen for prophylaxis of perioperative vasospasm, 1 mg/kg/min of diltiazem was continuously infused intravenously. Cardiopulmonary bypass (CPB) with two-stage venous cannula and aortic inflow cannula was established. The body temperature was naturally cooled down to 34°C. Combined antegrade and retrograde delivery of tepid blood cardioplegic solution was used intermittently every 15 minutes or after completion of each anastomosis. The skeletonized left internal thoracic artery (ITA) was anastomosed to the high lateral branch and the first diagonal branch sequentially. The left anterior descending artery was revascularized with skeletonized right ITA. The aortic cross-clamp time was 79 minutes. Free flow of each ITA was more than 100 ml/min. The heart started to contract shortly after the release of the aortic clamp in sinus rhythm (Fig. 1A). During the slowing down of the pump flow, the ST segment of the monitor ECG elevated (Fig. 1B). Attempts to wean off the CPB failed twice because of the elevation of the ST segment of the ECG. Coronary hypoperfusion syndrome

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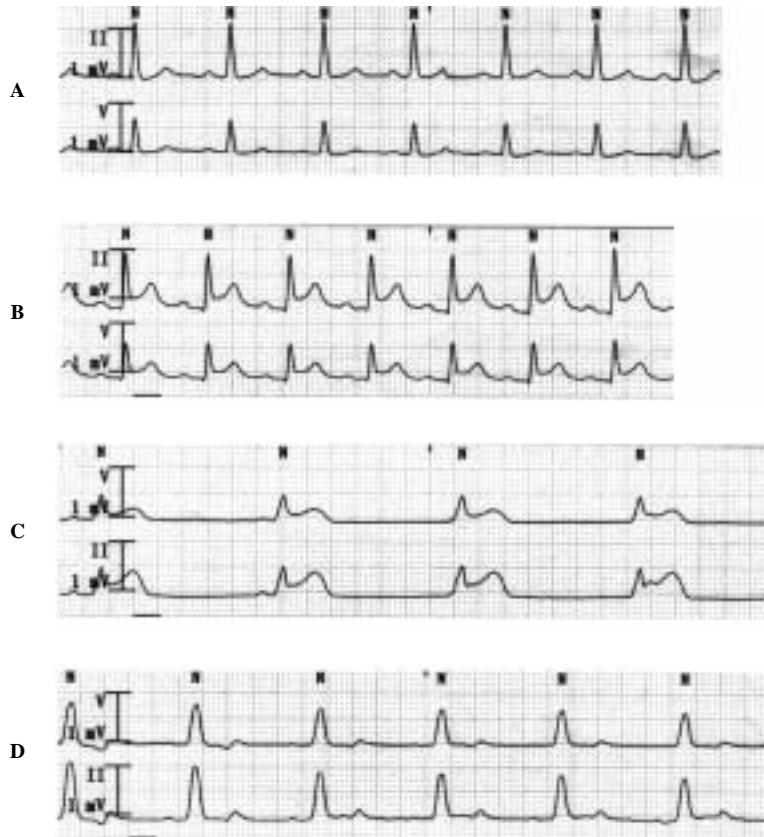


Fig. 1.

- A: Monitor electrocardiogram (ECG) before the first trial to wean off the cardiopulmonary bypass. No abnormal signs were detected.
- B: The ST segment elevated as the CPB flow was decreased.
- C: Monitor ECG before compulsory coronary perfusion showed elevation of the ST segment in leads II and V. Complete A-V block was also observed. Cardiac contraction was faint at this period.
- D: After completion of compulsory coronary perfusion, elevation of ST segment was resolved. A-V conduction was normalized.

was suspected. The CPB was resumed at full flow. An aorto-coronary saphenous vein graft (SVG) was added to the proximal portion of the second diagonal branch with the heart beating, and intra-aortic balloon pumping (IABP) was started. Even after addition of an SVG, the ST segment showed elevation in all the leads on the ECG monitor despite venting of the left ventricle, full flow CPB, and use of IABP. Several boluses of 10 mg of nitroglycerin (NTG) and 12 mg of nicorandil²⁾ each time through the aortic root cannula were temporarily effective, but soon the ST segment elevated again and again (Fig. 1C). In-

jection of the NTG and nicorandil through the SVG body³⁾ was also tried, but was effective only briefly. The ITAs did not show signs of vasospasm by inspection and palpation. Therefore, diffuse vasospasm of native coronary arteries was highly suspected. The heart was apparently failing with faint contraction. Transesophageal echocardiography also showed scarce contraction of left and right ventricles. We tentatively cross-clamped the ascending aorta and infused oxygenated pump blood into the aortic root through the cardioplegic cannula. The circuit and the small roller pump for infusion of antegrade

blood cardioplegia was utilized thus achieving compulsory perfusion of the heart through the coronary arteries and the vein graft. Both in-situ ITA grafts were temporarily clamped to prevent reverse steal of perfusate. The perfusion was started at a flow rate of 200 ml/min and gradually increased up to 500 ml/min. The maximum perfusion pressure at the aortic root was estimated to be about 150 mmHg. Boluses of 20 mg of NTG and 24 mg of nicorandil were shot through a three-way cock along the coronary perfusion line. The ST segment gradually dropped down to baseline in several minutes (Fig. 1D). After improvement of the ECG, the aortic root perfusion was continued at a pressure of 120 mmHg for several minutes. Then the aortic clamp and the clamps on the ITAs were released. The total time of compulsory coronary perfusion was 12 minutes. The patient was weaned off CPB with 3 μ g/min/kg of dopamine and dobutamine and the support of IABP. The ST segment of the ECG did not show elevation again. Wall motion of the left ventricle was almost normal on transesophageal echo. The endotracheal tube and the IABP were removed on the first and second postoperative day, respectively. Maximum creatine kinase level was 4,100 IU/L indicating perioperative myocardial infarction. The patient recovered without other complications. Postoperative ECG showed slight ST depression in leads V2 to V6 without Q wave. The coronary angiography performed one month postoperatively showed patent SVG opacifying almost all the left coronary system. The right ITA anastomosed to the LAD was patent, but the left ITA was occluded due presumably to competition with the blood flow through the SVG. The left ventricular ejection fraction was 62% with slight hypo-kinesis in the antero-septal wall.

Comment

Coronary vasospasm is still a devastating complication of cardiac surgery, which sometimes leads to a serious outcome. In this case, severe coronary vasospasm that was unresponsive to any usual treatments occurred subsequently to hypoperfusion syndrome. Coronary hypoperfusion syndrome is apt to occur when a large left anterior descending artery with critical proximal stenosis is revascularized using ITA.⁴⁾ In this case, use of bilateral

ITAs without SVG for critical LMT stenoses may have aggravated relative shortage of coronary flow during weaning from CPB. Usually, this syndrome is treated with addition of vein grafts or use of IABP.⁴⁾ However, in this case, an additional vein graft was not effective because of co-existing severe coronary spasm. We speculate that coronary spasm plays an important role in some patients with hypoperfusion syndrome.

We tentatively tried compulsory coronary perfusion as a rescue method to resolve intractable coronary spasm, inspired by the technique known as controlled aortic root reperfusion.⁵⁾ The compulsory coronary perfusion seemed to be effective against coronary spasm in two aspects. Firstly, oxygenated pump blood was infused at relatively high pressure, intending pressure-mediated dilatation of spastic vessels. Coronary perfusion pressure and coronary flow could be controlled independent of systemic perfusion pressure. Secondly, vasodilators were administered through the perfusion line so that they reach the coronary arteries at high concentration.

Based on this experience, we subsequently applied this technique successfully to the treatment of coronary air embolism. This technique is worth trying against intractable coronary spasm and air embolism during CPB.

References

1. He GW, Fan KY, Chiu SW, Cow WH. Injection of vasodilators into arterial grafts through cardiac catheter to relieve spasm. *Ann Thorac Surg* 2000; **69**: 625–8.
2. Mayumi H, Kawachi Y, Kohno H, et al. Drug infusion through a branch of aortocoronary vein graft for refractory coronary spasm. *Ann Thorac Surg* 1994; **58**: 869–71.
3. Noguchi T, Nonogi H, Yasuda S, et al. Refractory coronary spasm relieved by intracoronary administration of nicorandil. *Jpn Circ J* 2000; **64**: 396–8.
4. Caldeira CC, Char EA, Caldeira AS, Moreno-Cabral CE, McNamara JJ. Internal mammary hypoperfusion syndrome—diagnosis and treatment. *Jpn Circ J* 1997; **61**: 1011–4.
5. Allen BS, Buckberg GD, Fontan FM, et al. Superiority of controlled surgical reperfusion versus percutaneous transluminal coronary angioplasty in acute coronary occlusion. *J Thorac Cardiovasc Surg* 1993; **105**: 864–79; discussion 879–84.