Acute Type A Aortic Dissection Involving Malperfusion of Bilateral Coronary Arteries

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Coronary malperfusion associated with aortic dissection is fatal when it occurs. Although there are some case reports of coronary malperfusion involving a single coronary artery, the involvement of bilateral coronary arteries is extremely rare. The appropriate management of this fatal phenomenon remains controversial because of the difficulty in its accurate diagnosis and prompt treatment. We report 2 cases of type A aortic dissection with malperfusion involving bilateral coronary arteries.

In the first case, because aortography revealed acute type A aortic dissection (AAD) and coronary artery angiography (CAG) showed obvious bilateral coronary malperfusion the patient was transferred to the operation room without undergoing computed tomography (CT) scan after palliative revascularization at a catheter laboratory. The patient died of nonocclusive mesenteric ischemia in spite of postoperative medical treatment. In the second case, bilateral coronary artery malperfusion was not detected at the initial CT scan. Although detachment of the right coronary artery was detected during the operation, the left main coronary artery (LMCA) dissection was not detected until 1 week after the operation. When assessing the aortic root in a case of aortic dissection with coronary artery malperfusion, CT scan is not always satisfactory. Preoperative and postoperative catheter intervention is effective in aortic dissection with coronary malperfusion.

KEY WORDS: acute aortic dissection, coronary artery malperfusion, myocardial infarction

I. Introduction

The outcomes of AAD have improved over the years because of the establishment of a diagnostic technology and advancements in surgical treatment techniques. However, acute myocardial ischemia associated with aortic dissection is relatively rare and results in a critical condition of the patient.¹³

Although a definite method for treating an infarcted myocardium due to acute aortic dissection has not yet been established, it is extremely important to restore coronary circulation immediately.⁴⁻⁸ The effectiveness of the preoperative placement of a perfusion catheter or a coronary artery stent into the ischemic coronary artery has been demonstrated. However, it is particularly difficult to recognize coronary malperfusion because the patient’s hemodynamics is often unstable and there is no sufficient time to assess the patient thoroughly. Adequate assessment becomes more difficult if the malperfusion involves the bilateral coronary arteries.⁴⁻⁸

1. Case report 1

The first case was a 44-year-old man who suffered from loss of consciousness and cardiogenic shock upon arrival. The patient was transferred to a catheterization laboratory directly as acute coronary syndrome was suspected because of the ischemic changes shown on electrocardiography. Intra-aortic balloon pumping and percutaneous cardiopulmonary support were initially established, and aortography showed ascending aortic dissection (Fig. 1a), thus we were consulted as cardiologists. CAG revealed severe stenosis of the left main coronary artery (LMCA) dissection was not detected until 1 week after the operation. When assessing the aortic root in a case of aortic dissection with coronary artery malperfusion, CT scan is not always satisfactory. Preoperative and postoperative catheter intervention is effective in aortic dissection with coronary malperfusion.
induction revealed a floating dissecting flap in the aortic root. A modified Bentall operation using a 23 mm SJM® mechanical valve and a 28 mm Gelweave Valsalva woven graft® was performed because the entry of the aortic dissection located at the sinus of Valsalva was extensive and intraoperative TEE showed severe aortic valve regurgitation. Thereafter, we performed coronary artery bypass grafting (CABG) to the left anterior descending artery and the right coronary artery using great saphenous vein grafts. The orifice of the right coronary artery was completely detached from the aortic wall (Fig. 2).

Because TEE showed diffuse hypokinesis in the left ventricle, weaning from cardiopulmonary bypass was accomplished using percutaneous cardiopulmonary support and intra-aortic balloon pumping. Although weaning from percutaneous cardiopulmonary support was achieved on postoperative day 2, unfortunately, the patient died owing to septic shock on postoperative day 7. The autopsy revealed global myocardial infarction (Fig. 3a) and extensive necrosis in the intestine and colon (Fig. 3b and c).

2. Case report 2
The second case was a 50-year-old woman who suffered from severe chest pain. Preoperative CT scan revealed AAD. Howev-
er, the images were very poor to enable assessment of the aortic root (Fig. 4a and b) such that bilateral coronary artery malperfusion was not detected. TEE in the operation room revealed a floating dissecting flap in the aortic root (Fig. 5) and total arch replacement was performed. Because complete detachment of the right coronary artery was found during the emergency operation (Fig. 6), additional CABG was performed to the right coronary artery using a great saphenous vein graft. The orifice of the left coronary artery appeared to be intact. Valve-sparing aortic root replacement was not selected and only repair of the false lumen using fibrin glue was performed because the aortic regurgitation was trivial and detachment of the false lumen was found to be limited. Selective coronary cannulation was not used during the operation. Despite the patient’s unstable hemodynamics and left ventricular dysfunction on TEE, weaning from cardiopulmonary bypass was achieved eventually. Postoperative CT scan showed good adhesion of the false lumen. However, on postoperative day 7, the patient suffered from sudden and severe chest pain. Electrocardiography showed broad ST-segment elevation and emergency CAG revealed severe stenosis at the proximal site of the LMCA owing to coronary artery dissection (Fig. 7). Therefore, emergency percutaneous coronary intervention (PCI) was performed with the primary deployment of a 5.0×16 mm bare metal stent into the LMCA; the symptom disappeared after the revascularization. Intravascular ultrasound was not performed to avoid injury to the orifice because LMCA dissection was obvious on CAG (Fig. 7).
The outcomes of surgical repair for AAD have improved over the years because of the establishment of a diagnostic technology and advancements in surgical treatment techniques. However, AAD with coronary artery malperfusion is fatal because of the difficulty in making an accurate diagnosis and administering an appropriate treatment. The incidence of coronary malperfusion ranges from 6\% to 11\% in clinical reports \(^1\)\(^,\)\(^2\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,...\) The reported hospital mortality rate of an aortic dissection with coronary malperfusion is extremely high at 33.3\% \(^1\). Even though several case reports in which this condition was treated successfully have been published, most of them involved a single coronary artery \(^4\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\). The incidence of bilateral coronary malperfusion is extremely low, and there are few studies reporting its successful treatment. To our knowledge, the true mortality rate of this condition is unknown; however, the rate should be higher than that of a single coronary malperfusion. Imoto et al. reported that preoperative cardiopulmonary arrest and myocardial ischemia, particularly of the left coronary artery territory, negatively affected the survival outcomes of patients undergoing surgery for type A aortic dissection with coronary artery dissection. Early coronary intervention via stent implantation effectively prevents postoperative low cardiac output syndrome. Several bridge approaches to surgery have consequently been developed to facilitate early coronary intervention and reduce the extent of myocardial cell necrosis \(^8\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\)\(^,\). In terms of mechanism, Neri et al. \(^2\) reported 3 types of coronary malperfusion. In the first case described above, the right coronary artery was classified as type C malperfusion, namely, detachment of the coronary orifice, and the left main trunk was classified as type B malperfusion, namely, dissection of the coronary artery. The second case described above was the same as the first case in which the right coronary artery was classified as type C malperfusion and the left main trunk was classified as type B malperfusion. The accurate mechanism of these coronary artery malperusions was not readily evident at the initial CT scan and CAG. In the second case, coronary artery malperfusion was not detected at the initial CT scan. Moreover, type B malperfusion of the left main trunk was not detected even during the operation. Type A malperfusion is compression of the coronary orifice by a dissection flap. In many type A cases, the malperfusion can be treated by only aortic repair; however, type B malperfusion often requires CABG to gain efficient blood flow. Moreover, some cases of type C malperfusion require not only CABG but also aortic root repair because of the detachment of the coronary artery orifice and aortic root. In the first case, root replace-
ment was required in addition to CABG. In the second case, the right coronary artery orifice detachment was repaired using fibrin glue because the detachment was limited to the right-sided sinus of Valsalva.

As most cases with coronary malperfusion are initially recognized as having acute coronary syndrome because of the ischemic changes on electrocardiography upon admission, CAG is performed in a catheterization laboratory before other examinations similarly to the first case. If aortography apparently reveals type A aortic dissection, an emergency surgical repair should be considered without an additional CT scan. Nevertheless, CT scan is recommended as the first line of investigation for patients with suspected type A aortic dissection, however, CT scan is more time consuming and dangerous for critical shock patients. Moreover, CT scan is occasionally poor at assessing the aortic root because of the heart beat and unstable hemodynamics of the patients.

Unfortunately, because of the unavailability of a hybrid operation room, the first case was brought to a catheter laboratory instead of an operation room. Upon completion of the hybrid operation room, all surgical processes will be performed in this operation room.

Although aortic dissection involving the left coronary artery occurs less frequently than aortic dissection involving the right coronary artery, it is more frequently lethal and more urgent. Several case reports have indicated that previous PCI was effective as it provides faster perfusion than CABG. Barabas et al. reported successful bridge therapy to open surgery by restoring the hemodynamics with LMCA stenting. Only the placement of a perfusion catheter into the dissected coronary artery was also effective in recanalizing the coronary perfusion. The first case, the hemodynamics markedly stabilized after stent implantation into the left main trunk and perfusion catheter placement into the right coronary artery. Although CABG remains the gold standard for treating an LMCA lesion, PCI may be permanently effective in some cases wherein the stenotic lesion is localized or in some cases with many comorbidities. PCI may act as a definitive treatment in cases that show coronary malperfusion after surgical treatment such as in the second case. Hori et al. reported the successful treatment of LMCA malperfusion by PCI alone after aortic repair in AAD complicated by coronary dissection. Herein, our approach is based on the concept that CABG is preferable, with PCI as a possible alternative. Using a saphenous vein graft is preferable as the revascularization method because the saphenous vein is more suitable than other artery grafts for gaining quick and sufficient blood flow in ischemic coronary arteries.

Intraoperative TEE is also very useful for estimating both cardiac function and valve function. Moreover, TEE is very useful for the assessment of aortic dissection. In the first case, at the time of cardiopulmonary bypass weaning, intra-aortic balloon pumping and percutaneous cardiopulmonary support were administered to stabilize the hemodynamics because TEE showed diffuse hypokinesis in the anteroseptal wall. In the second case mentioned above, at the time of cardiopulmonary bypass weaning, even though the hemodynamics was slightly unstable and TEE showed hypokinesis in the anteroseptal wall, we managed to wean from cardiopulmonary bypass without any cardiac support systems. During the surgery, left coronary malperfusion should have been checked in the second case. If TEE shows left ventricular dysfunction during the surgical treatment, additional CABG should be considered. Imoto et al. reported 7 patients who had myocardial ischemia with decreased left ventricular wall motion at the time of weaning from the cardiopulmonary bypass after aortic repair. Kawahito et al. similarly reported that ischemia developed after weaning from cardiopulmonary bypass in 3 of 12 patients with coronary artery dissection accompanied by ischemia. The development of ischemia was most likely caused by pressure differences occurring between the true lumen and the false lumen at the aortic root after repair, rather than the extension of dissection to the coronary arteries after the aortic repair.

Even if appropriate revascularization is performed immediately, extensive myocardial infarction and low cardiac output syndrome can occur after surgical treatment. This depends on the damaged myocardial area, and some cases require mechanical support (e.g., intra-aortic balloon pumping and percutaneous cardiopulmonary support). Needles to say, intra-aortic balloon pumping is contraindicated for aortic dissection. However, we occasionally use this procedure for a case of aortic dissection with left ventricular dysfunction, and there have been several reports about this treatment in aortic dissection cases. If weaning from mechanical support is difficult because of left ventricular dysfunction despite various inotropic medications, immediate implantation of a stronger assist device should be considered. Asakura et al. strongly recommended the use of a left ventricular assist system before the exacerbation of multiple organ failure in this situation. Unfortunately, the first case died of sepsis owing to ischemic colitis. Pathological findings revealed extensive necrosis in the intestine and colon; however, there was no dissection or occlusion of visceral arteries. From these findings, non-occlusive mesenteric ischemia was suspected because of circulatory insufficiency owing to severe cardiac dysfunction. In this case, implantation of a left ventricular-assisted device should have been considered immediately after the operation.
III. Conclusion

In conclusion, we report 2 treated cases of AAD involving bilateral coronary artery malperfusion. CT scan is not always necessary in cases of obvious aortic dissection as shown by other examination procedures because coronary malperfusion is occasionally not detected clearly by CT scan. PCI may be effective before and even after aortic repair. TEE is important for detecting aortic dissection and assessing left ventricular function. Additional CABG should be considered if weaning from cardiopulmonary bypass is difficult and TEE shows left ventricular dysfunction.

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Conflict of interest

All authors have no disclosures to make and have received no financial support for this study.

Abbreviations

Computed tomography (CT), coronary artery angiography (CAG), coronary artery bypass grafting (CABG), left main coronary artery (LMCA), trans esophageal echocardiography (TEE), percutaneous coronary intervention (PCI)

References