Treatment Strategy for Acute Type A Aortic Dissection Complicated with Organ Ischemia

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Objective: We report our current treatment strategy for acute type A aortic dissection with organ ischemia as well as notable findings in our experience.

Materials and Methods: Among 101 cases of acute type A aortic dissection, 25 had organ ischemia. Malperfusion was assessed at the aorta, proximal portion of the branch, organ parenchyma, and organ function by means of multiple modalities, including transesophageal echocardiography (TEE), near-infrared spectroscopy, and physical examinations. It was assessed every time the perfusion status was altered.

Results: There were three operative deaths and one late hospital death. Uncertainty of symptoms and inadequate preoperative assessment in an emergent situation indicated the necessity of an overall check-up of organ ischemia in the operating room on a routine basis. Multi-modality assessment including TEE was helpful for this purpose. Two cases indicated that recovery of a true lumen could be inadequate despite true lumen perfusion including central cannulation. Thrombus in the false lumen appeared to be responsible.

Conclusions: To solve practical problems in treating acute type A dissection with organ ischemia, real-time information on organ perfusion is important for detecting the presence of malperfusion, making an appropriate strategy, and immediately assuring the efficacy of the means taken.

Keywords: aortic dissection, malperfusion, surgery, echocardiography, near-infrared spectroscopy

INTRODUCTION

Aortic rupture and organ ischemia are the two main causes of early death in patients with type A aortic dissection.1–3) The former leads to an unpredictable abrupt onset of circulatory derangement with systemic malperfusion. The latter starts at the onset of dissection or later in the subsequent course and is progressive unless perfusion is adequately restored. Thus, we have made it a rule to transfer the patient to the operating room even without adequate preoperative assessment in order to avoid irreversible damage of the ischemic organ and/or catastrophe due to aortic rupture before surgery.

Organ ischemia is present in 20% to 40% of cases with acute aortic dissection with various symptoms.4–6) While irreversible organ damage on arrival is beyond the realm of treatment, further progress of ischemic damage should be minimized. Considering the possibility of persistent ischemia despite every effort of restoring perfusion, we have attempted to shed a light on the blind zone during surgery. This paper is aimed to report our current treatment strategies against organ ischemia associated with acute type A aortic dissection, as well as notable findings obtained in our experiences.
MATERIALS AND METHODS

Between 1997 and 2010, among 101 consecutive cases of acute type A aortic dissection, 25 (24.8%) had associated organ ischemia before surgery. They included 17 male and 8 female patients, 34 to 83 years old (mean age: 62.3 years old). The ischemic organ included myocardium, brain, upper extremity, spinal cord, intestine, kidney, or lower extremity in 5, 11, 7, 1, 4, 5, and 8 cases, respectively (two, three, or four organs in 7, 3, and 1 case(s), respectively). Eight cases (32%) were hypotensive (<80 mmHg) at arrival due to myocardial ischemia or pericardial tamponade.

The initial diagnosis of aortic dissection and associated complications was made by computed tomography (CT) either in our hospital or in the previous hospital. As long as the diagnosis of the dissection was definite, the patient was immediately transferred to the operating room without an additional CT assessment, even if the image quality was inadequate for us to determine the detailed surgical strategy.

After the induction of anesthesia, transesophageal echocardiographic (TEE) was instituted for the preoperative assessment (EUB-555, Hitachi Co, Tokyo, Japan; SSD 5500, Aloka Co., Tokyo, Japan; iE33, Philips Electronics Co., Netherland) including 1) presence and extent of dissection, 2) presence of rupture to the pericardial and/or pleural space, 3) aortic regurgitation (AR), 4) location of entry, 5) global and regional function of ventricles, and 6) dissection and perfusion in the coronary artery, arch branch arteries and visceral branches.7–10 The surgical strategy was finally determined, based on the TEE assessment and preoperative CT findings. In addition, regional oxygen saturation in the bilateral frontal lobes was continuously monitored throughout the surgery with a near-infrared spectroscopy (NIRS) system TOS-96 (TOSTEC Co., Tokyo, Japan).11 When cerebral malperfusion was suspected, orbital Doppler was carried out using a conventional transthoracic echocardiographic probe, which was equipped in the TEE system.12)

The priority of perfusion was 1) systemic, 2) brain and heart, and 3) intestine and limbs. As long as the patient was hemodynamically stable, an 8-mm ePTFE vascular graft was anastomosed to bilateral axillary arteries with 6–0 polypropylene in an end-to-side fashion. Following median sternotomy, cardiopulmonary bypass was established with the right axillary arterial perfusion and drainage from a two-staged venous cannula. When there was extended dissection or stenosis in the right subclavian artery, the left axillary artery was used for arterial perfusion. When the patient was in shock status, the femoral artery was cannulated for arterial perfusion to assure the systemic perfusion with minimal delay. In both situations, perfusion in various organs was assessed mainly using TEE, NIRS, and orbital Doppler.13 The aorta was repaired under circulatory arrest at the rectal temperature of 25 degrees centigrade and selective cerebral perfusion via the bilateral axillary arteries and a cannula inserted into the left common carotid artery. In case of ischemic limb, the femoral artery was selectively perfused through a cannula which was directed distally.

Figure 1 shows the sites and modalities for assessing the perfusion in each organ. It was checked at one or more sites among 1) the aorta (orifice of branch artery), 2) proximal portion of branch artery, 3) small artery in the parenchyma, or 4) tissue or organ function by means of TEE, NIRS, orbital Doppler, Doppler flowmeter, or physical examination. Perfusion was newly assessed whenever perfusion status was altered, i.e., at the initiation of systemic perfusion and selective perfusion, reperfusion after revascularization, and aortic declamping. If malperfusion was detected, the perfusion routes were changed or added. The efficacy of such strategy was immediately evaluated to avoid an inappropriate navigation.

RESULTS

The surgical procedures for aortic repair were ascending aorta replacement, total arch replacement, or aortic root replacement in 19, 3, and 3 cases, respectively. There were three operative deaths (11.5%) and one late hospital death (3.8%). All of three cases of operative death were in shock status at the start of operation. Among the 11 cases with cerebral ischemia, 5 cases had sustained consciousness disturbance or cerebral infarction, while the remaining 6 cases had no significant sequelae. Several illustrative cases are presented.

A 65 year-old male patient (case #6) with a history of coronary artery bypass grafting (CABG) had a sudden onset of numbness and dull pain in both arms.14) The CT assessment revealed acute type A dissection with compressed true lumen in the descending to abdominal aorta. Bilateral, radial arteries were hardly palpated. Ultrasonography demonstrated an obstruction in the bilateral axillary arteries (Fig. 2A). Blood gas analysis showed metabolic acidosis with base excess level of −10 mEq/L, which was not accountable solely with the upper limb ischemia. Although he had no abdominal pain and
the superior mesenteric artery (SMA) was opacified in the CT assessment, the Doppler flow was hardly detectable in the SMA and collateral blood flow into the SMA was detected (Fig. 2B). The peristalsis of intestine was very weak although there was no wall thickening or ascites. We concluded that mesenteric ischemia was significant. We had to make a decision to select either of aortic repair or revascularization of SMA and axillary arteries. There was no rupture or malperfusion in other organs at this time. Since he had a history of CABG, aortic rupture was unlikely to lead to critical pericardial tamponade due to adhesion. A left common iliac to SMA bypass was made with a saphenous vein graft, and the bilateral axillary arteries were fenestrated. The color and peristalsis of the intestine immediately improved, and dull pain in the arm disappeared. The base excess returned to a normal range. Although he developed localized pericardial tamponade with mild hypotension, he underwent aortic repair and had a good postoperative course without complication.

A 57 year-old male patient (case #24) suddenly had...
lumbago and dull sensation in the legs. CT showed type A dissection with right kidney infarction and obstruction in the right femoral artery (Fig. 3A). Although the left external iliac artery was occluded, the left femoral artery was perfused by the collateral circulation from the internal iliac artery. Echocardiography showed moderate to severe AR. Following right axillary artery perfusion, blood flow in the right foot remained undetectable. As we cannulated the right common femoral artery and started selective distal perfusion, blood flow in the right foot became detectable instantaneously. After replacement of the ascending aorta, AR became less than mild. The right femoral artery was transected, and the stump was repaired. However, the blood flow became undetectable again in the right foot and looked pale. Since the limb had been appropriately perfused via a cannula, thrombus in the false lumen near the cannulation site was likely to have collapsed the true lumen (Fig. 3B). Thrombus in the false lumen was carefully aspirated by several centimeters. After revision of arterial repair, the foot was well perfused (Fig. 3C). Although he developed mild compartment syndrome in the right lower leg and necessitated fascial incision and subsequent skin graft, the leg function fully recovered after several months.

A 54 year-old male patient (case #22) with a history of aortic valve replacement had a sudden onset of weakness in his bilateral legs. The CT assessment revealed type A aortic dissection and total occlusion of the abdominal aorta. Upon arrival, the anterior to posterior wall of the left ventricle was akinetic. TEE revealed total occlusion in the left coronary ostium and every visceral artery (Fig. 4A). In shock status, he was put on bypass with femoral arterial perfusion. The true lumen was soon restored in the aorta, but not in the coronary artery and SMA (Fig. 4B). In order to minimize the ischemic time, the aorta was cannulated by Seldinger method under TEE guidance. However, the coronary artery was hardly perfused, and the true lumen in the SMA remained smaller than 50% of the entire lumen (Fig. 4C). There was thrombus in the false lumen. After dissection of severe pericardial adhesion, the ascending aorta was replaced. The coronary artery became adequately perfused, and the left ventricle was slightly contracting. However, the true lumen in the SMA remained small (Fig. 4D). At this moment, we decided a laparotomy. Although the stomach, liver, jejunum, and sigmoid colon was well perfused, the ileum was necrotic. Unfortunately, the improvement of left ventricular contraction was not adequate, and the patient died the next day.

A 34 year-old female patient (case #25) with Marfan syndrome and a history of type B aortic dissection had a sudden onset of severe abdominal pain with nausea and vomiting. She presented with consciousness disturbance (JCS 30) and left hemiplegia. CT revealed type A aortic dissection without apparent low density area or hemorrhage in the brain. The visceral arteries were opacified. TEE showed mild hypokinesis in the right ventricle, avulsion of right coronary ostium but with detectable

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**Fig. 3** Computed tomograms (CT) and schematic illustration of mechanism for malperfusion in case #24. A: Preoperative CT image with occlusion of right femoral artery. B: Mechanism of malperfusion in the right femoral artery. Thrombus in the false lumen (FL) was responsible. True lumen (TL) was compressed. C: Postoperative CT image.
blood flow, moderate AR, narrow true lumen in the right common carotid artery, and patent SMA (Fig. 5). Based on these findings, we decided aortic root replacement without a laparotomy. She had good operative course without neurological or abdominal complications.

**DISCUSSION**

The current study has elucidated the problems in the surgical treatment of acute type A aortic dissection with organ ischemia: 1) fallible symptoms; 2) limited time for preoperative assessment; and 3) persistent malperfusion despite true lumen perfusion.

Symptoms of patients are often misleading. Case #6 complained of dull pain in the arms but not abdominal pain despite the presence of significant mesenteric ischemia. In case #22, symptoms of myocardial and mesenteric ischemia was masked by the weakness of legs. In contrast, case #25 complained of abdominal pain, but mesenteric ischemia was not present. These results indicate that an overall check-up for organ ischemia during routine care is essential.
However, patients are often hemodynamically unstable, as was noted in 32% of cases in this series due to pericardial tamponade and/or myocardial ischemia. Once a major rupture to the pericardial or pleural space occurs, it becomes extremely difficult to save the life of a patient. Therefore, it is important to put the patient on cardiopulmonary bypass with minimal delay.

In the clinical setting, the quality of CT assessment is often inadequate for making a definite surgical strategy. Thus, we have used intraoperative TEE to obtain the essential information including location of entry, severity of AR, presence of rupture or malperfusion in any organ. In case #25, the absence of mesenteric ischemia was confirmed by CT and TEE despite abdominal pain at the onset, and we could spare time for the laparotomy and concentrate on the aortic repair.

Two cases in this series (case #22 and #24) demonstrated that a recovery of true lumen can be inadequate despite true lumen perfusion. In case #22, malperfusion in the coronary artery and the SMA was persistent despite femoral arterial perfusion and central cannulation, whereas the true lumen in the aorta was immediately restored. This can be a pitfall of central cannulation and suggests the importance of immediate assessment of new perfusion status. The finding in case #24 illustrates the mechanism of persistent malperfusion. The thrombus in the false lumen can interfere with a recovery of true lumen because it occupies space in the vessel and does not dissolve in a short period. However, it is difficult to aspirate the thrombus in the false lumen of SMA or coronary artery during surgery. Bypass surgery or catheter intervention would be a better strategy. While there is always a risk of persistent malperfusion in any organ, it is hardly predictable. It is not practical to set the angiography system ready for every surgical case. A realistic way to detect such an occurrence and make an appropriate decision would be to monitor the perfusion status in each organ at real time by means of modalities listed in Fig. 1.

Conclusions

In acute, type A aortic dissection complicated with organ ischemia, preoperative assessment is often inadequate. Furthermore, malperfusion in the organ can persist despite true lumen perfusion. To solve these problems, real-time information on organ perfusion is important for detecting the presence of malperfusion, making an appropriate strategy, and immediately assuring the efficacy of the means taken.

References

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