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Two-Stage Endovascular Repair for Concurrent Penetrating Atherosclerotic Ulcers of the Thoracic and Abdominal Aorta

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We report a case of concurrent saccular aneurysms caused by a penetrating atherosclerotic ulcer of the thoracic and abdominal aorta that were successfully treated by staged endovascular repair. Even though surgical open repair or endovascular repair is the treatment option, use of endovascular repair is now accepted as an alternative treatment to surgery in selected patients. To prevent contrast medium-induced nephropathy and spinal cord ischemia caused by a simultaneous endovascular procedure, a saccular aneurysm of the descending thoracic aorta was excluded by stent graft, followed by the placement of a bifurcated stent graft in the infrarenal abdominal aorta one month later.

Key words: 1. Aortic aneurysm
2. Endovascular procedures
3. Contrast media
4. Spinal cord ischemia

CASE REPORT

A 66-year-old man was transferred to our hospital for the treatment of two asymptomatic saccular aneurysms caused by a penetrating atherosclerotic ulcer in the descending thoracic aorta and the infrarenal abdominal aorta. All of the laboratory data were within normal range except serum creatinine. The level of serum creatinine was slightly high at 1.5 mg/dL. A computerized tomography (CT) scan demonstrated that a saccular aneurysm measuring 60 mm in the longest diameter in the descending thoracic aorta was at the level of the 9th thoracic vertebra, and the other saccular aneurysm measuring 55 mm in the longest diameter in the infrarenal abdominal aorta was at the level of the 3rd lumbar vertebra (Fig. 1). We decided to perform staged endovascular repair on this patient in order to prevent contrast-induced nephropathy by reducing the total amount of contrast material administered, and to prevent paraplegia that could occur if the long segment of the aorta were covered with a stent graft in one session. In addition, we tried to avoid the risk of rupture while waiting for the second endovascular procedure by decreasing the interval time between the staged procedures.

During the first stage, a 34×100 mm stent-graft, a self-expandable custom-made type (S&G Biotech Inc., Seongnam,

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Fig. 1. A computerized tomography angiogram shows a saccular thoracic aortic aneurysm (arrowhead) and another saccular abdominal aneurysm (arrow) in the left oblique view.

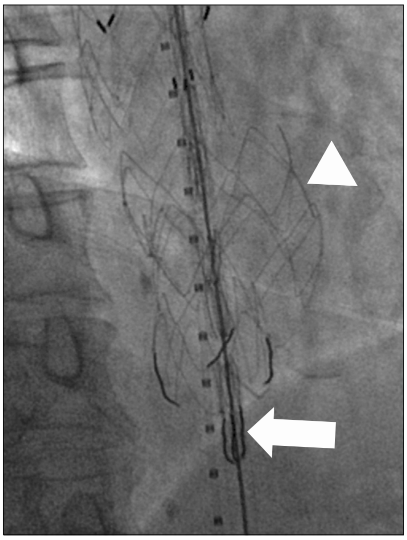

Fig. 2. During the first stage, a 34×100 mm stent-graft, a self-expandable custom-made type was deployed along the thoracic saccular aneurysm. An additional same-sized stent-graft (arrow) was used because of a wind-sock effect (arrowhead).

Korea), was deployed along the thoracic saccular aneurysm and spinal fluid drainage was performed to prevent paraplegia. Additional 36×80 mm stent-graft was used because of a wind-sock effect (Fig. 2). During this procedure, 200 mL of nonionic and iso-osmolar contrast medium iodixanol (Visipaque; Nycomed Imaging AS, Oslo, Norway) was used. In the second stage, one month later, Zenith stent-grafts (Cook Inc., Minneapolis, MN, USA) were placed from the saccular abdominal aneurysm to both common iliac arteries, thereby excluding the aneurysm from circulation. During this second stage, 240 mL of iodixanol (Visipaque, Nycomed Imaging AS) was used. Perioperative cerebrospinal fluid drainage was performed to prevent spinal cord ischemia (SCI). The patient presented no perioperative deterioration of renal function or paraplegia. A ten-month follow-up CT angiogram showed both stent-grafts were patent with no evidence of thrombus, endoleak, aneurysm growth, or complications derived from the procedure (Fig. 3). Two-stage endovascular repair may therefore be used to successfully treat separate saccular thoracic and abdominal aortic aneurysms without any deterioration of renal function or paraplegia.

Fig. 3. A ten-month follow-up computerized tomography angiogram demonstrated the patency of both stent-grafts with no evidence of thrombus or endoleak.

DISCUSSION

Simultaneous multiple aortic aneurysms still pose a number of problems in deciding on proper treatment. Historically, multilevel aortic surgery was performed simultaneously or in stages. Although a staged operation could decrease the procedure-related mortality, the rupture of a residual aneurysm could occur while waiting for the second operation [1]. Since the advent of endovascular repair, several authors have asserted the effectiveness of simultaneous placement of separate stent grafts without a greater risk of serious procedure-related complications than with surgical repair [2,3]. However, there might be two drawbacks to one-stage endovascular repair in multilevel aortic disease. One is the potential for contrast medium-induced nephropathy, which is associated with the total dose of administration and preexisting impairment of renal function. The other concern is a high risk of post-procedure paraplegia by covering the long segment of the aorta with stent grafts. Therefore, in deciding on a simultaneous or staged endovascular procedure in the uncommon case of synchronous and separate saccular aneurysms of the thoracic and abdominal aorta, many factors should be taken into account, including the general status, surgical anatomy, and the disease entity.

As the surgical anatomy in this case was amenable to endovascular repair, endovascular repair was attempted. We considered simultaneous or staged endovascular treatment. However, we were concerned about the potential for contrast medium-induced nephropathy (CMIN) due to the large amount of contrast media (CM) needed and about the high risk of post-procedural paraplegia given the need to cover the long segment of the aorta with a stent-graft during a simultaneous endovascular procedure. A two-stage endovascular treatment was thus favored.

CMIN is the third most common cause of hospital-acquired acute renal failure, and in half the cases it occurs after invasive cardiovascular procedures [4]. Various factors may be involved in identifying an increased risk of CMIN, including impairment of renal function preceding CM administration, hypovolemia and/or dehydration, the amount of CM, and previous medication, among others. Although the most frequently used test in the clinical evaluation of glomerular function is the serum creatinine level, elderly patients often experience a truly significant decrease in the glomerular filtration rate (GFR) despite apparently normal serum creatinine values because of the reduced total muscular mass typical of old age [5]. The serum creatinine level and GFR of this patient were 1.3 mg/dL and 60 mL/min/1.73 m^2, respectively (Modification of Diet in Renal Disease Study Equation). There currently are parameters for estimating the maximum volume of CM to prevent CMIN. It has been reported that the maximum dose of CM to administer to a patient is (5 mL×the number of kilograms of body weight [maximum 300 mL]) divided by the serum creatinine level (expressed in mg/dL). A correction factor of 1.5 should be considered for new CM with lower osmolality [6]. The maximum dose of CM for this patient by this equation was 250 mL. A more precise equation has been suggested which calculates the ratio between the CM dose (in grams of iodine) and the estimated GFR (I-dose/GFR ratio). At a mean I-dose/GFR ratio=1, the regression line indicates a 10% risk of a serum creatinine rise ≥20% to 25% from baseline values because the study shows a linear correlation between the I-dose/GFR ratio and the frequency of CM-induced damage [7]. The dose of CM for this patient was 200 mL when the I-dose/GFR ratio was 1.0. If simultaneous endovascular treatment of the thoracic and abdominal aortic aneurysms had been done for this patient, the I-dose/GFR would have been 2.44 and the risk of CM-induced damage would have been raised to about 50%.

Endovascular treatment avoids aortic cross clamping and its consequences. However, SCI after endovascular aortic repair is a serious complication. In open repair of thoracic aortic pathologies, aortic cross clamping may alter spinal cord blood perfusion and a number of ancillary techniques have been published [8]. Even in endovascular stent-graft repair of isolated descending thoracic aortic aneurysms, SCI remains a serious complication with a reported frequency that ranges from 0% to 12.0% and several factors can increase the risk of SCI. These factors include previous abdominal aortic aneurysm repair, aortic occlusion, long stent-graft, perioperative hypotension, and cerebrospinal fluid drainage [9,10]. According to the aortic map proposed by Ishimaru [11], at least 4 zone numbers from T8 to T11 in the thoracic aorta and 4 zone numbers from L2 to L5 in the abdominal aorta should be excluded with this patient. The length of the deployed stent-graft was expected to be at least 8 zone numbers. The length of the stent-graft is one of the risk factors for SCI and prior abdominal aortic aneurysm repair may produce a greater risk of SCI by a possible compromise of the pelvic and hypogastric collateral that supply the anterior spinal artery [12,13].

To reduce the risk of CMIN and SCI, a two-stage endovascular procedure was planned for the case presented here; the first stage involved thoracic endovascular aortic repair and the second involved abdominal endovascular aortic repair.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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