Long-Term Outcomes of Surgical Treatment with In Situ Graft Reconstruction for Secondary Aorto-Enteric Fistula

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Objectives: The optimal surgical management for secondary aorto-enteric fistula (sAEF) is controversial. Here, we report the long-term outcomes of a surgical treatment with in situ graft reconstruction for sAEF that was performed at our hospital.

Methods: Between 2009 and 2012, 10 consecutive patients (8 males, 2 females, mean age 75.9 years) with sAEF were surgically treated with in situ graft reconstruction. Perioperative and long-term outcomes were reviewed retrospectively by medical records.

Results: Clinical manifestations, including gastrointestinal bleeding, shock, sepsis, and back and abdominal pain, were observed during the treatment of the patients. In all the cases, the fistula was found between the duodenum or small intestine and the graft anastomosis, the graft itself, or pseudoaneurysm. Total graft excision and in situ graft reconstruction with omental coverage and digestive tract reconstruction was performed for all cases. There were two operative deaths because of multiple organ dysfunction syndrome and sepsis. The other patients showed no sAEF related complications, such as graft infection, and were alive during the 54-month mean follow-up period (33–76 months).

Conclusion: According to our study, the long-term outcomes of surgical treatment with in situ graft reconstruction for sAEF were considered satisfactory. (This article is a translation of Jpn J Vasc Surg 2016; 25: 1–6.)

Keywords: graft infection, aorto-enteric fistula, in situ reconstruction

Introduction

A secondary aorto-enteric fistula (sAEF) is a rare complication, occurring in 0.3%–1.6% of patients who have undergone graft replacement of the abdominal aorta, and is characterized by gastrointestinal erosion and fistula formation due to adhesion between the graft and gastrointestinal tract.1,2)

The diagnosis and treatment of sAEFs are often difficult. Bleeding due to aortic disruption or aortic/graft infection leads to sepsis, and the mortality rate early after operation has been reported to be 18%–54%.2–13)

Vascular reconstruction after removal of the infected graft had been the conventional method of surgery for sAEFs, and is performed by extra-anatomical bypass grafting.1–5) However, extra-anatomical bypass grafting is associated with high rates of postoperative aortic stump re-infection or disruption, lower limb amputation, and death.2,3) In recent years, in situ vascular reconstruction has been mainly performed.6–10)

With the widespread use of stent grafts, studies using endovascular repair for sAEFs have also been performed.11–13) Endovascular repair is minimally invasive and is useful in patients with transient control of bleeding, and has produced favorable short-term results. However, considering the pathology of sAEFs, this method may not be a good choice of radical treatment due to the residual graft and intestinal fistula. Favorable longer-term outcomes cannot be expected due to the recurrence of sepsis.14)

In our department, sAEFs have been treated by complete resection of the infected graft and intestinal fistula with in situ vascular reconstruction, with favorable results. In this study, we evaluated the results of in situ reconstruction in 10 patients with sAEFs treated between 2009 and 2012.

Subjects and Methods

The subjects consisted of 10 consecutive patients with sAEF formation who underwent surgery in our
department between January 2009 and December 2012.

In each patient, medical records were retrospectively investigated, and symptoms, the course until diagnosis, treatment principles, and outcomes were evaluated. The postoperative survival rate was calculated using the Kaplan Meier method.

**Results**

**Background of the patients**

Table 1 shows the background of the patients. The patients consisted of eight males and two females aged 63–85 years (mean, 76 years), at the time of surgery for sAEFs.

All 10 patients had undergone graft replacement of the aorta below the renal arteries for abdominal aortic aneurysms. The period from the initial operation for aortic aneurysms to the sAEF onset was 1–176 months (mean, 75.5 months).

The underlying diseases treated by the initial aortic operation included a ruptured abdominal aortic aneurysm in one patient, inflammatory aortic aneurysm in another, and non-ruptured aortic aneurysm in nine including one with an infected aortic aneurysm. The initial operation was performed in our department in two patients and in other institutions in the other eight.

As for symptoms, gastrointestinal bleeding was observed in 4 of the 10 patients including 2 with herald bleeding as a symptom characteristic of this disease. Of the four patients, three were in hemorrhagic shock when transported to our hospital. The other six patients showed fever, low back pain, and/or abdominal pain.

**Diagnosis**

In three (patients No. 4, 5, 9) of the four patients with gastrointestinal bleeding, upper gastrointestinal endoscopy had been performed by the previous physician.

In one patient (No. 5) of them, the bleeding source could not be identified. In the other two patients (No. 4, 9), erosion and bleeding were confirmed in the mucosa of the horizontal portion of the duodenum, and a diagnosis of a duodenal ulcer was made. In one (patient No. 4) of the two patients, since the bleeding tended to resolve, the course was followed up. The other (patient No. 9) underwent clipping for the control of bleeding, but had recurrence of bleeding later, and was transported to our hospital in a state of shock. In our hospital, each patient was diagnosed with sAEF formation based on the disease history and findings after laparotomy.

On the other hand, the patients with fever, low back pain, and/or abdominal pain had been diagnosed with fever of unknown cause or vascular graft infection by the

| Patient no. | Age | Gender | Symptoms | Indication of initial aortic reconstruction | Comorbidities |
|-------------|-----|--------|----------|---------------------------------------------|--------------|
| 1           | 63  | M      | Back pain, Fever | AAA (ruptured) | HT, DM, PAD |
| 2           | 67  | M      | Fever | AAA | CI |
| 3           | 81  | M      | Melena, shock | AAA (inflammatory) | IHD, HT |
| 4           | 78  | M      | Melena, shock, Fever, Melena | AAA (infectious) | AAA |
| 5           | 83  | M      | Fever | AAA | AAA |
| 6           | 61  | F      | Fever | AAA | AAA |
| 7           | 74  | M      | Hematemesis, Melena, Shock | AAA | AAA |
| 8           | 68  | M      | Fever | AAA (ruptured) | AAA |

*AAA: abdominal aortic aneurysm, CI: cerebral infarction, DM: diabetes mellitus, HT: hypertension, IHD: ischemic heart disease, PAD: peripheral artery disease, sAEF: secondary aorto-enteric fistula*
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of the duodenal wall followed by primary suturing was performed in four patients, duodenal transection followed by reconstruction by elevating the jejunum in two patients, and partial resection of the small intestine followed by reconstruction by end-to-end anastomosis in four patients.

The mean operative time was 410 minutes, and the mean blood loss was 2719g. The mean aortic cross-clamping time was 111 minutes, and the mean postoperative hospital stay was 8.0 days (Table 2).

There were two operation-associated deaths. Both patients had been in shock before the operation. One showed persistent shock during surgery and died of multiple organ failures 24 days later. The other had severe sepsis before the operation and died without recovering from sepsis three days after surgery.

As for postoperative complications, pneumonia was observed in one patient, ileus in two (Both showed improvement after conservative treatment), and acute myocardial infarction (treated by percutaneous coronary intervention (PCI)) in one.

Appropriate postoperative antibiotics were selected based on culture results (Table 3) and administered by drip infusion for 2 to 4 weeks. After negative conversion

previous physician, treated with antibiotics, but transported to our hospital due to no improvement in symptoms. CT was performed, and a diagnosis of sAEF formation was made based on findings such as peri-graft soft tissue hypertrophy, peri-graft fluid retention, and air bubbles (Fig. 1).

Treatment principles and outcomes

Emergency laparotomy was performed in all patients, since the clinical course and CT findings strongly suggested sAEF.

The period from the onset to the diagnosis and surgery for sAEFs was 0–130 days (mean, 28.3 days). Regarding the type of sAEF, a direct fistula to the anastomotic site between the aorta and graft was observed in three patients, a fistula to an aneurysm at the anastomotic site in three, and a fistula due to contact with the graft wall in four. The fistula was found in the duodenum in six patients and small intestine in four patients.

During surgery, the infected graft and intestinal fistula were resected after laparotomy, and debridement of the surrounding infected tissues was performed, followed by in situ vascular reconstruction using a rifampicin-soaked graft or the autogenous superficial femoral vein (SFV). In all patients, omentoplasty was performed in order to cover the entire length of the graft.

A patient (patient No. 4), in whom an SFV graft was used, had undergone femoro-femoral artery bypass surgery. Therefore, direct replacement from the aorta to right iliac artery was performed (Fig. 2). In another patient (patient No. 6), a Y-shaped SFV graft was produced and used for replacement.

The intestinal reconstruction method differed according to the range of the fistula resection. Partial resection of the duodenal wall followed by primary suturing was performed in four patients, duodenal transection followed by reconstruction by elevating the jejunum in two patients, and partial resection of the small intestine followed by reconstruction by end-to-end anastomosis in four patients.

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**Table 2**  Detail of operative and long-term outcomes

| Patient no. | Fistula         | Aortic reconstruction | Reconstruction of digestive tract | Complication   | Operative time (min) | Blood loss (g) | Aorta clamp (min) | ICU stay (day) | Hospital stay (day) | Follow up period (month) |
|-------------|-----------------|-----------------------|-----------------------------------|----------------|----------------------|----------------|-------------------|----------------|---------------------|--------------------------|
| 1           | Small intestine | In situ               | Partial resection of small intestine | Ileus          | 210                  | 85             | 43                | 4             | 42                  | 66.5                     |
| 2           | Small intestine | In situ               | Partial resection of small intestine | Pneumoniae     | 264                  | 1237           | 41                | 7             | 43                  | 76.2                     |
| 3           | Duodenum        | In situ               | Duodeno–jejuno stomy              |                | 460                  | 4125           | 158               | 4             | 27                  | 73.6                     |
| 4           | Small intestine | In situ (SFV)         | Partial resection of small intestine | Sepsis (death) | 482                  | 5070           | 211               | 3             | 3                   | 0.1                      |
| 5           | Small intestine | In situ               | Partial resection of small intestine |                | 550                  | 215            | 95                | 12            | 48                  | 55.7                     |
| 6           | Duodenum        | In situ (SFV)         | Excision of fistula               | Ileus          | 522                  | 1845           | 96                | 4             | 33                  | 46.6                     |
| 7           | Duodenum        | In situ               | Excision of fistula               |                | 291                  | 2589           | 97                | 7             | 23                  | 33.7                     |
| 8           | Duodenum &      | In situ               | Excision of fistula partial resection of small intestine |                | 495                  | 7688           | 106               | 7             | 13                  | 48.1                     |
|             | intestine       |                       |                                   |                |                      |                |                   |               |                     |                          |
| 9           | Duodenum        | In situ               | Duodeno–jejuno stomy              | MODS (death)   | 414                  | 15460          | 150               | 24            | 24                  | 0.8                      |
| 10          | Duodenum        | In situ               | Excision of fistula               | AMI (PCI)      | 420                  | 2850           | 116               | 7             | 26                  | 38.1                     |

AMI: acute myocardial infarction; ICU: intensive care unit; MODS: multiple organ dysfunction syndrome; PCI: percutaneous coronary intervention; SFV: superficial femoral vein
of C-reactive protein (CRP), the antibiotics were orally administered on an outpatient basis consecutively for 3 months or longer, in principle. After excluding patients who developed side effects, antibiotic administration was continued for 3 months to 5 years.

After excluding patients who died early after the operation, the other eight patients survived for a longer duration (33.7–76.2 months; median, 51.9 months). The five-year survival rate associated with sAEF was 80%. Since a patient died of a malignancy 5 years after the operation, the overall five-year survival rate was 53%. Both the graft patency rate and lower limb amputation avoidance rate after 5 years were 100%.

**Discussion**

sAEF is a rare condition, with only a few reports in existence regarding its surgical results and long-term outcomes. In our department, we performed in situ vascular reconstruction for sAEFs and obtained long-term favorable results without re-infection.

sAEFs mostly manifest as gastrointestinal bleeding, abdominal pain, or fever. In this study, sAEFs presented as gastrointestinal bleeding in 4 out of 10 patients. Upper gastrointestinal endoscopy, which was performed in three of the four patients, identified the bleeding site in two patients. The bleeding site may be difficult to identify because bleeding has often stopped before endoscopy, observation is difficult due to fistulas often occurring in the horizontal portion of the duodenum, and fistulas are small when observed from the mucosal surface. Both patients in whom the bleeding site was identified showed a small area of erosion and bleeding in the horizontal portion of the duodenum. However, since the bleeding volume was small, the course was observed in one of the two patients, and the bleeding was stopped by clipping in the other. At the time of endoscopy, sAEF was not diagnosed in either.

The diagnosis of Aortoenteric fistula (AEF) by gastrointestinal endoscopy is difficult, and the cause of bleeding can be misrecognized when there are complications such as duodenal ulcers or hemorrhagic gastritis. Diagnosing of sAEFs using only endoscopy is difficult. Unless sAEFs are suspected, diagnosis and treatment can be delayed.

Herald bleeding, which is a characteristic warning sign of this disease, was observed in two patients in our study. However, neither patient was diagnosed with sAEF at the time of herald bleeding, and they were transported due to shock caused by massive gastrointestinal bleeding that subsequently occurred.

Since overlooking this disease can be fatal, a high index of suspicion for sAEFs is essential when gastrointestinal bleeding occurs in patients with abdominal aneurysms or those with a history of graft replacement of the abdominal aorta. Careful endoscopic evaluation of the horizontal portion of the duodenum is necessary. In addition, sAEFs should not be excluded even when the bleeding site cannot be identified by endoscopy.

Computed Tomography (CT) has often been useful for diagnosing sAEFs. When hematomas are observed in the gastrointestinal lumen that is continuous with the aneurysmal wall, the presence of sAEFs is clear. Findings indicating infection/inflammation (such as thickening of peri-graft soft tissue and its increased enhancement), the presence of pseudo-aneurysms at the anastomotic site, and high air density in the peri-graft area, strongly suggest sAEFs.

Unless radical surgery is performed, gastrointestinal bleeding repeatedly occurs, resulting in shock sooner or later, and survival becomes difficult. Radical surgery, which consists of the control of bleeding, resection of the infected tissue and graft, gastrointestinal reconstruction after resection of the fistula, and vascular reconstruction, should be performed as soon as the diagnosis is made in patients who can tolerate the procedure.

Definite diagnosis is difficult by imaging alone. When clinical symptoms and diagnostic imaging findings strongly suggest sAEFs, surgery should be performed without hesitation.

Regarding vascular reconstruction methods, extra-anatomical bypass grafting has been the convention.
An advantage of this method is that it is not necessary to use the graft at the infection site. However, previous studies have shown the following sequelae: lower limb amputation in 9%, new infection of the graft in 15%, and obstruction of the extra-anatomical bypass graft in 18%.\(^2\) or bleeding from the aortic stump in 15%.\(^3\) The death rate early after operation has been reported at 23%–44%.\(^6,7\)

Since these surgical results were unsatisfactory, in situ vascular reconstruction has been used in recent years.\(^8-10\)

Using in situ vascular reconstruction, excellent long-term graft patency is expected, and blood flow to the lower limb is adequately maintained. Since there is no aortic stump, there is no risk of aortic stump disruption.

In our department, in situ vascular reconstruction using the autogenous SFV has been performed as the first choice in patients with severe infection or a large abscess. However, due to a difference in the orifice diameter between the SFV and aorta, it is difficult to obtain the graft length adequate for the replacement area. In order to mitigate the effects of a prolonged operative time, and surgical invasion, rifampicin-soaked grafts have been used for reconstruction in patients with localized infection. Since there are risks of re-infection of the synthetic vascular graft and recurrence of fistulation, adequate intraoperative debridement and omentoplasty are performed, and appropriate antibiotics are administered for long periods. Using either graft, none of our patients have shown graft obstruction, lower limb amputation, or graft re-infection.

In recent years, due to the marked invasiveness of in situ vascular reconstruction and previous poor surgical results, treatment using stent grafts has occasionally been reported.\(^11-13\) Endovascular stent graft repair is minimally invasive, is useful for the transient control of bleeding, and associated with favorable short-term results. However, due to the residual infected graft and intestinal fistula, considering the sAEF pathology, it cannot be regarded as radical treatment. Due to the possible development of local infection and aggravation of sepsis, favorable longer-term outcomes cannot be expected.\(^14\)

On the other hand, the short-term results and long-term outcomes of radical surgery using in situ vascular reconstruction were favorable, and we consider this procedure as the standard surgical procedure for sAEFs. Endovascular stent graft repair can be chosen as an emergency evacuation measure to control bleeding for shock; but even in such cases, radical surgery should be performed as soon as possible after stabilization of the patient's general condition.

**Conclusion**

Surgery consisting of graft resection, resection of the intestinal fistula, in situ vascular reconstruction, and omentoplasty for sAEFs can be safely performed, and is associated with favorable long-term outcomes.

However, when shock or severe sepsis is already present before operation, survival is difficult, and early diagnosis and surgery are important before herald bleeding or graft infection becomes severe.

**Disclosure Statement**

All co-authors have no conflict of interest.

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