Early Experience with Fenestrated Stent Grafts for Treatment of Juxtarenal Aortic Aneurysm

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Background: Fenestrated endovascular abdominal aneurysm repair (FEVAR) using branched arteries devices for visceral arteries is increasingly being used for the repair of juxtarenal aortic aneurysms (JAAs) in Europe, United States, Australia, New Zealand, and Asia. This study aimed to evaluate the technical feasibility and short-term results of FEVAR in treating JAAs in Japanese patients.

Methods and Results: FEVAR with Cook fenestrated stent-graft (Cook Medical Inc., Bloomington, Indiana, USA) was performed for 5 patients at high risk for open repair of JAA. Seventeen visceral vessels were successfully accommodated with 12 fenestrations, and five visceral arteries with four scallops with a loss of renal artery. In one case, a type III endoleak occurred at a renal artery fenestration, and this had disappeared in the 1-month postoperative computed tomography (CT). The mean follow-up duration was 8 months. Iliac leg occlusion occurred in 1 case, which was treated with thrombectomy and additional leg device deployment. All patients had survived at the end of the follow-up period and continued their outpatient visits.

Conclusions: Implantation of a Cook fenestrated stent-graft incorporating the visceral arteries is technically feasible in high-risk Japanese patients with JAA and may be a viable alternative to current methods.

Keywords: juxtarenal aortic aneurysm, fenestrated stent-graft, branched stent-graft, conduit graft, brachio-femoral artery shunt

INTRODUCTION

Endovascular abdominal aortic aneurysm repair (EVAR) has been performed in more than 20000 cases in Japan since Zenith (Cook Medical Inc., Bloomington, Indiana, USA) stent-graft device was approved for clinical use on July 11, 2006.1) The safe and minimal invasiveness of the technique has promoted its widespread use across the entire country.2) However, the commercial EVAR devices currently available in Japan require that the aortic proximal neck be placed at least 10 mm in length below the lower renal artery, which precludes the application of EVAR in short-necked and juxtarenal aortic aneurysms (JAAs). Open repair with aortic clamping above the renal arteries is the gold standard for treatment of JAAs.3,4) On October 25, 2005, the Zenith Fenestrated AAA Endovascular Graft (Cook Medical Inc., USA) received the first Conformité Européenne (CE) mark in Europe. On April 4, 2012, the Food and Drug Administration (FDA) approved the device for commercial use in the United States. The device is
now widely used in Europe, United States, Australia, and New Zealand. The early and mid-term outcomes of this device have been favorable in these western countries.\textsuperscript{5–7)} Among Asian countries, the Cook fenestrated device is approved by the government in Taiwan, Hong Kong, China, Thailand, Malaysia, Singapore, and India at this time point. However, in Japan, it is uncertain when the device will be approved by the government because of the so-called “device lag” in the Japanese system, and the introduction of the device may be delayed significantly. A literature search pertaining to the use of EVAR with a Cook’s fenestrated device in Asian countries revealed only 1 report on 2 cases in which fenestrated EVAR (FEVAR) had been performed using branched devices for the renal arteries.\textsuperscript{8)} The purpose of the present study was to describe our initial experiences with the treatment of JAA using the fenestrated stent-graft, including 2 cases in which the device was equipped with a scallop for the celiac artery and 3 fenestrations for endovascular branching for the superior mesenteric artery (SMA) and renal arteries of both sides. In this initial series, we also performed the technique using an iliac artery conduit in 2 cases because external iliac arteries had a small diameter. Here, we report our initial results of the surgical procedures and a short-term follow-up study.

\textbf{MATERIALS AND METHODS}

\textbf{Patient selection and device preparation}

Between March and December 2012, 5 patients with asymptomatic JAA underwent elective deployment of the Zenith fenestrated stent-graft at our department. A JAA was defined as aneurysm with a neck length of ≤5 mm. The research protocol was reviewed and approved by the institutional Review Board. Written informed consent was obtained from all patients. All patients were classified using the guidelines of the American Society of Anaesthesiologists (ASA), and were considered to be at high risk for conventional open repair. The main indication for FEVAR included a proximal neck that was too short for standard EVAR. Zenith fenestrated endovascular stent-grafts were individually imported from the United States and were financed with research grants from Hamamatsu University School of Medicine or its delegated account. The devices were customized for each patient’s use, on the basis of multiplanar reconstruction (MPR) images and centerline of flow images using a three-dimensional (3D) workstation (Aquarius NetStation; TeraRecon, San Mateo, California, USA). Assistance in device customization was provided by Zenith Endovascular Planning (A Division of William A. Cook, Australia, Brisbane, Australia). Advanta V12 stent grafts (Atrium Medical, Hudson, New Hampshire, USA), which were used for visceral branching, were also imported as mentioned before. These devices were used for FEVAR, with the use of each device being covered by private health insurance under a contract between the private insurer and our institute.

\textbf{Technical aspects of the fenestrated stent graft}

The device was customized for each patients use. The details of the device was described earlier.\textsuperscript{9)} Briefly, the stent-graft is a modular endovascular prosthesis based on the Zenith AAA endovascular graft (Cook Medical Inc., USA) A 3-part composite system, including a proximal tubular body containing the fenestrations (proximal component), a distal bifurcated graft (distal component), and a contralateral limb, was used in most cases. The clock position of the branch ostia was determined on the basis of MPR images. Usually, small fenestrations (6 × 8 mm) are used for renal arteries, and large fenestrations (8 × 8 mm) with scallops are used for the celiac artery or SMA.

\textbf{Stent graft placement}

All procedures were performed under general anesthesia. The femoral arteries of both sides were exposed either by oblique or longitudinal skin incision. If the external iliac arteries were narrow, thereby necessitating the placement of a conduit for the insertion of the proximal component systems, a 10 mm knitted dacron graft (Hemashield Gold, Maquet Cardiovascular, LLC, Wayne, New Jersey, USA) was anastomosed to the common iliac artery in an end-to-side manner through a retroperitoneal approach. The conduits were then used as a bypass graft for ilio-femoral artery bypass after completion of the stent graft deployment. All patients received intravenous injections of 2000–3000 U of heparin just before femoral artery cannulation, with additional boluses of heparin being administered, according to the intraoperative activated clotting time (ACT) values. The main body of the graft was initially deployed (20F sheath size), followed by cannulation of the fenestrations with subsequent placement of Atrium V12 (Atrium Medical, USA) covered stents within the SMA and renal arteries. For cannulation of the SMA and renal arteries of both sides, multiple insertions of 7F Ansel sheath (Cook Medical Inc., USA)
in each fenestration were performed at the common femoral artery of the contralateral side. To avoid development of persistent ischemia of a lower limb during sheath insertion through the femoral artery, a brachio-superficial femoral artery shunt was performed by the insertion of a 5F sheath insertion at both brachial artery and superficial femoral artery in all patients except patient #1. Placement of the distal bifurcated component and additional contralateral iliac leg was performed after deployment of the Advanta V12 stent graft at all fenestrations of the proximal component. The technique used in the procedure is similar to that employed in the deployment of the conventional bifurcated Zenith AAA endovascular graft.

Results

Demographic data

Five patients (4 men and 1 woman) underwent FEVAR (Table 1). The patients were of ASA grade 2 or 3, and their comorbidities and demographic data are summarized in Table 1. The patients had a mean age of 73.2 years (range, 71–75 years). The mean maximum aneurysm diameter (A-P view) was 55.4 mm (range, 52–63 mm). The mean neck length was 2.8 mm (range, 0–5 mm); mean diameter of the supra-renal sealing zone, 26.2 mm (range, 25–27 mm); mean length of the sealing zone, 30.2 mm (range, 20–45 mm). The mean proximal neck angulation was 25.8° (range, 2–45°).

A standard fenestrated device with bilateral renal artery fenestrations was used in 3 cases, whereas custom-made devices were used in 2 cases, in which 3 branched stent-grafts (SMA and both renal arteries) with Advanta V12 were used.

Technical aspects of fenestrated stent graft placement

All of the Advanta V12 covered stents were postdilated/flared at the fenestration to create a seal between the Advanta V12 and the fenestrated stent grafts. In patients #2 and #5, who underwent SMA endovascular branching, a Luminexx stent (Bard, Inc, Murray Hill, New Jersey, USA) was placed in the distal side of the SMA and was overlapped with an Advanta V12 covered stent.

In patients #4 and #5, the conduits were anastomosed to the left common iliac artery in an end-to-side manner by using a 10 mm Hemashield knitted Dacron graft through a retroperitoneal approach because the size of minimum diameter of the external iliac arteries was insufficient for the insertion of the proximal component system (20-F). The left hypogastric arteries were ligated. In both cases, the distal end of the bifurcated devices was placed inside the conduit graft (Fig. 1).

Perioperative results

The mean fluoroscopy time was 132 minutes (range, 75–166 minutes). The mean amount of iodinated contrast medium used in the procedure was 170 mL (range, 125–240 mL). The mean operative time was 408.8 minutes (range, 343–485 minutes). The mean estimated intraoperative blood loss was 694.8 mL (range, 260–1028 mL). Perfusion was maintained at all target branch vessels after the procedure, except in the case of patient #3, wherein the left renal artery was lost, and therefore the left renal accessory artery was branched with an Advanta V12 covered stent. In this patient, the postoperative creatinine levels did not differ from the preoperative values.

A type III endoleak was noticed in patient #5 at the interface between the fenestration and the left renal artery orifice (Fig. 2). Despite repeated flaring/ballooning at the renal artery, the endoleak did not disappear. In the remaining 4 cases, completion angiography demonstrated successful exclusion of the aneurysm. Patient #1 developed persistent left leg swelling due to ischemia and subsequent reperfusion injury. The patient’s postoperative serum creatine kinase levels were more than 10000 U/ml until the 7th postoperative day. The leg swelling remained for more than 20 days. The mean length of postoperative hospital stay was 16.6 days (range, 11–28 days; Table 2).

Follow-up

The mean follow-up period was 8.6 months (range, 5–15 months). The type III endoleak in Patient #5 was found to have resolved at the 1-month postoperative CT scan. All branched vessels with Advanta V12-covered stents were patent. Patient #4 showed deterioration of the preoperative renal insufficiency (serum creatinine 1.4 mg/dL). His creatinine level elevated to 2.5 mg/dL postoperatively; therefore, the postoperative CT with contrast material was cancelled. On the 27th day after the initial FEVAR, he was readmitted to our hospital with left leg pain and cyanosis. He was diagnosed with acute limb ischemia due to thrombotic occlusion of the left limb of the distal component. Non-contrast CT showed dislocation of the distal end of the left leg of the distal component, which was originally placed inside the conduit graft (left ilio-femoral bypass) (Fig. 3A). The left
## Table 1 Outline of patient demographics and technical aspects of Cook fenestrated stent-graft placement

<table>
<thead>
<tr>
<th>Pt</th>
<th>Age/Sex</th>
<th>Comorbidity</th>
<th>ASA score</th>
<th>AAA AP diameter (mm)</th>
<th>Infrarenal neck length (mm)</th>
<th>Angle supra/infra renal (degree)</th>
<th>Scallop for a branch arteries</th>
<th>Fenestrations for branch arteries</th>
<th>Additional procedure other than endovascular stent-graft placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>72/M</td>
<td>Severe COPD, smoking, Hypertension</td>
<td>3</td>
<td>52</td>
<td>4</td>
<td>40/75</td>
<td>None</td>
<td>Bilateral renal arteries</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>71/F</td>
<td>History of twice laparotomies</td>
<td>2</td>
<td>63</td>
<td>1</td>
<td>45/22</td>
<td>Left gastric artery, Common hepatic artery, Splenic artery</td>
<td>SMA, Bilateral renal arteries</td>
<td>Bare stent placement at SMA, Brachio-Femoral artery shunt</td>
</tr>
<tr>
<td>3</td>
<td>74/M</td>
<td>COPD, smoking Greater pectoral muscle flap for neck cancer</td>
<td>2</td>
<td>54</td>
<td>5</td>
<td>44/74</td>
<td>SMA</td>
<td>Bilateral renal arteries</td>
<td>Brachio-Femoral artery shunt</td>
</tr>
<tr>
<td>4</td>
<td>75/M</td>
<td>COPD, smoking, Recent history of gastric ulcer bleeding</td>
<td>3</td>
<td>55</td>
<td>2</td>
<td>2/48</td>
<td>SMA</td>
<td>Bilateral renal arteries</td>
<td>Iliac conduit, Brachio-Femoral artery shunt, Common iliac artery-Common femoral artery bypass</td>
</tr>
<tr>
<td>5</td>
<td>74/M</td>
<td>Ischemic heart disease</td>
<td>3</td>
<td>53</td>
<td>2</td>
<td>5/45</td>
<td>Celiac artery</td>
<td>SMA, Bilateral renal arteries</td>
<td>Iliac conduit, Brachio-Femoral artery shunt, Common iliac artery-Common femoral artery (I-F) bypass, Bare metal stent placement at the proximal anastomosis of I-F bypass</td>
</tr>
</tbody>
</table>

Pt: patient; ASA: American Society of Anesthesiologists; AAA: Abdominal aortic aneurysm; AP: anteroposterior; COPD: chronic obstructive pulmonary disease; SMA: superior mesenteric artery; I-F: ilio-femoral
Fig. 2 (A) An intraoperative angiography of the left renal artery in patient 5 showing placements of guiding sheaths in the SMA and renal arteries of both sides. (B) Completion angiography in patient #5 showing a type III endoleak at the interface between the fenestration and the left renal artery orifice. Arrow indicates leakage of the contrast medium from the fenestration of the left renal artery. SMA: superior mesenteric artery; RA: renal artery; I-F: ilio-femoral

Table 2  Perioperative outcomes and complications during the follow-up

<table>
<thead>
<tr>
<th>Pt</th>
<th>Fluoroscopy time (minutes)</th>
<th>Contrast dose (mL)</th>
<th>Operative time (min)</th>
<th>Estimated blood loss (mL)</th>
<th>Endoleak</th>
<th>Postoperative hospital stay (days)</th>
<th>F/U time (months)</th>
<th>Complications, F/U</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>166</td>
<td>240</td>
<td>343</td>
<td>260</td>
<td>None</td>
<td>28</td>
<td>15</td>
<td>Intractable leg edema</td>
</tr>
<tr>
<td>2</td>
<td>142</td>
<td>163</td>
<td>435</td>
<td>760</td>
<td>None</td>
<td>12</td>
<td>9</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>145</td>
<td>155</td>
<td>485</td>
<td>800</td>
<td>None</td>
<td>18</td>
<td>8</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>75</td>
<td>125</td>
<td>366</td>
<td>626</td>
<td>None</td>
<td>11</td>
<td>6</td>
<td>Stent-graft leg occlusion, renal function deteriorated</td>
</tr>
<tr>
<td>5</td>
<td>131</td>
<td>166</td>
<td>415</td>
<td>1028</td>
<td>Type III</td>
<td>14</td>
<td>5</td>
<td>None</td>
</tr>
</tbody>
</table>

Pt: patient; F/U: follow-up
Fenestrated Stent-Graft for Juxtarenal Aortic Aneurysm

JAA. Conventional surgery in these patients often involves a more complex repair than the standard open repair of infrarenal AAA because a proximal anastomosis in the short neck or placement of an aortic cross-clamp in a higher position can cause technical difficulties. In particular, these technical difficulties pose an increased risk of mortality and morbidity for patients with a history of laparotomy; comorbidities such as coronary artery disease; renal insufficiency; history of steroid use; and chronic obstructive pulmonary disease. Recent reports of the open repair of JAA have revealed that the perioperative mortality ranges from 2.5% to 6.3%. The endovascular approach is expected to be beneficial to treat JAA in the high risk patients. An alternative method for the use of a standard EVAR device for JAA is the “chimney” or “snorkel” technique, which preserves the renal arteries in stent-graft sealing zones. Although short-term studies have indicated that the technique may be feasible, most of these studies have limited the use of the techniques in less than two snorkels. Moreover, the occurrences of type I endoleaks were not rare ranging from 7% to 12%. In contrast, a fenestrated stent-graft allows the preservation of more than 3 visceral vessels, i.e., both renal arteries, the SMA, and the celiac artery thereby ensuring the maintenance of stent-graft sealing zones for a long duration. Recent reports from high-volume vascular centers and multi-centers trials

iliac leg was kinked and then occluded. Emergency thrombectomy was performed under general anesthesia. After the thrombectomy, an additional iliac leg of the Zenith AAA endovascular graft (TFLE14-73, Cook Medical Inc., USA) was deployed to extend the left leg inside the ilio-femoral bypass graft. Then, an uncovered stent (Luminexx stent, Bard, Inc, USA) was placed inside the iliac leg across the proximal anastomosis of the ilio-femoral artery bypass to straighten the graft kink (Fig. 3B). The patient recovered from acute leg ischemia; however, his serum creatinine levels elevated to 3.4 mg/dL at discharge from our hospital, and he was monitored thereafter using CT without contrast material and duplex scanning.

**DISCUSSION**

This study shows that FEVAR with a Cook fenestrated stent-graft is technically feasible and provides favorable short-term results in Japanese patients with JAA who are unfit for open-repair. Randomized controlled trials in patients undergoing EVAR revealed an early survival advantage, with the risk of perioperative death with EVAR being significantly lower than that with open repair. However, a JAA cannot be treated using a standard EVAR because of a short infrarenal neck; therefore, open repair is currently the gold standard for the treatment of JAA. Conventional surgery in these patients often involves a more complex repair than the standard open repair of infrarenal AAA because a proximal anastomosis in the short neck or placement of an aortic cross-clamp in a higher position can cause technical difficulties. In particular, these technical difficulties pose an increased risk of mortality and morbidity for patients with a history of laparotomy; comorbidities such as coronary artery disease; renal insufficiency; history of steroid use; and chronic obstructive pulmonary disease. Recent reports of the open repair of JAA have revealed that the perioperative mortality ranges from 2.5% to 6.3%. The endovascular approach is expected to be beneficial to treat JAA in the high risk patients. An alternative method for the use of a standard EVAR device for JAA is the “chimney” or “snorkel” technique, which preserves the renal arteries in stent-graft sealing zones. Although short-term studies have indicated that the technique may be feasible, most of these studies have limited the use of the techniques in less than two snorkels. Moreover, the occurrences of type I endoleaks were not rare ranging from 7% to 12%. In contrast, a fenestrated stent-graft allows the preservation of more than 3 visceral vessels, i.e., both renal arteries, the SMA, and the celiac artery thereby ensuring the maintenance of stent-graft sealing zones for a long duration. Recent reports from high-volume vascular centers and multi-centers trials...
from Europe and United States have indicated good results of FEVAR using a Cook fenestrated stent-graft for JAA at both initial and mid-term follow-ups.\textsuperscript{5,19,20} A recent literature review indicated that FEVAR can be performed with a 30-day mortality rate of 2.1%,\textsuperscript{21} which is comparable to the rate for standard EVAR. Although the use of the fenestrated stent-graft has been increasing in western countries after its use was approved by certain governments, it is uncertain when the Japanese government will approve the device with health insurance coverage. The future of the device in Japan is unknown. The anatomy of the abdominal aorto-iliac artery in Asians is different from that in western populations: the former generally have a smaller stature and smaller vessels. Therefore, caution must be exercised when using a fenestrated stent-graft in this region. The common iliac artery in Asians is often shorter and wider than that in their Western counterparts.\textsuperscript{22} The length between the renal artery branch and aortic bifurcation may be lesser in Asians, which would make the distal component of the device too long, if the device was originally designed according to Caucasian anatomy. In this series, custom-made devices were used in 3 of the 5 cases and were manufactured according to their patients’ own anatomy. Therefore, the off-the-shelf availability of the device in the United States may not be suitable for Asian populations. For introducing FEVAR and establishing supply systems in Asian countries, it is necessary to accumulate anatomical data as well as surgical experiences in their local population. Furthermore, the size of external iliac artery in Asians is smaller than that in Westerners, which makes the procedure more difficult not only for sheath insertion but also catheter manipulation for branching multiple fenestrations.

Our initial experience revealed some technical difficulties. In patient \#3, we could not introduce a guidewire into the left renal artery. This might be due to the poor preoperative planning for the fenestration. The patient had a severe infrarenal angulation (74°) so that the position of the left renal artery might have changed after the placement of the proximal component of the device. Although the postoperative CT identified the left renal infarct, no sign of endoleak was evident, and the patient’s creatinine levels stayed within the normal range. In patient \#5, a type III endoleak occurred at a renal artery fenestration on completion angiography; however, this endoleak resolved by the 1-months postoperative CT scan. Although the follow-up period in this study was short (mean follow-up duration, 8.6 months), all 5 patients had survived at the end of the study period and did not have an endoleak. One patient with preoperative renal insufficiency (serum creatinine level, 1.4 mg/dL) showed postoperative deterioration of renal function (serum Creatinine level, 2.5 mg/dL). However, no patients required hemodialysis. In 2 patients, conduit grafts were used to introduce a proximal component system measuring 20-Fr because the diameters of the external iliac arteries on both the sides were <6 mm. The complications encountered in this series raise certain issues that need to be sheared with FEVAR endovascular teams around the world. One of the 2 patients in whom the conduit graft was used developed the leg occlusion due to a kink at the leg of the distal component, which was placed inside the conduit graft. He underwent emergency leg thrombectomy. Then, an additional leg stent-graft was deployed to extend the distal sealing zone inside the conduit graft; subsequently, an uncovered stent was placed inside the leg to straighten the kink. Whenever touch-up procedures are performed for the distal component leg inside the conduit grafts, care should be taken to avoid kinking the leg by providing an adequate sealing zone. In such cases, the placement of an additional uncovered stent inside the leg may be helpful to straighten the kink. In Asians, who have smaller external iliac arteries than Caucasians, the use of a conduit graft may be needed more frequently than in Caucasians. Furthermore, when 3 fenestrations for endovascular branching were used to place stent-grafts at the SMA and both renal arteries were applied, three 7-F sheaths were simultaneously advanced inside the proximal component through the iliac arteries after insertion from the contralateral common femoral arteries. These multiple sheath insertions may hinder the blood flow to the contralateral iliac arteries and cause leg ischemia during the procedure. In patient \#1, persistent leg swelling occurred postoperatively, possibly due to the prolonged leg ischemia. To avoid the leg ischemia and subsequent reperfusion injury, we placed a temporal brachio-superficial femoral artery shunt during the FEVAR in patient \#2 to \#5. The shunt maintained the blood flow to the contralateral leg and prevented ischemic damages. Neither leg swelling nor leg ischemic events occurred in the remaining 4 patients who underwent stent implantation. To prevent leg ischemia and minimize the risk of reperfusion injury and the associated metabolic consequences, some surgeons advocate the use of routine axillo-femoral bypass grafts for complex fenestrated graft procedures.\textsuperscript{23} The placement of our brachio-femoral shunt is technically easier than
that of axillo-femoral bypass grafts. However, the blood flow obtained through 5-F sheath is limited, possibly rendering it less than the axillo-femoral bypass graft in perfusing the legs. The choice of either technique may be a matter of surgeons’ preference, on a case-by-case basis. These additional procedures may be beneficial particularly when multiple fenestrations are needed to complete FEVAR or for the endovascular teams on a learning curve.

The overall results of the mean fluoroscopy time of 132 minutes, operating time of more than 6 hours, with a blood loss of 700 ml, and contrast volume of 170 ml seemed to be larger than those in previous studies which reported in the results of similar procedures.24,25 This can be attributed to several factors: (1) Learning curve. These five were our first ever cases of FEVER. (2) Two cases required iliac conduits, which were used as bypass grafts for ilio-femoral bypass after the FEVER. (3) Two cases required three-fenestrations (SMA and bilateral renal arteries) (4) An adjunctive procedure of brachio-femoral artery shunt placement was performed in four cases. (5) Two major intraoperative difficulties were encountered: one was the loss of the hemilateral renal artery, and the other is type III endoleak at the renal artery fenestration. (6) Due to the lack of a hybrid operative room in our hospital, all procedures were performed in an angiography suite although standard EVAR is routinely performed using a mobile C-arm in the operative room in our hospital. Therefore, the angiography suite was not well equipped for EVAR. Moreover, the medical stuffs in the room were not accustomed to the procedures. These are the possible reasons for the increase in not only the operative time but also the amount of blood loss.

Although FEVAR may become an alternative method to treat JAA in high-risk patients, the procedure has several limitations. First, more than 1 month is required for the design and manufacture of the custom-made device; therefore, the technique cannot be used in emergency cases, such as ruptured aneurysm, unless an effective off-the-shelf supply system is established. Second, a severely angled supra-renal aorta would make the fenestration design extremely difficult for the accurate deployment of a stent-graft for the visceral vessels. Third, the procedure is technically demanding and may be associated with a longer learning curve than that of the standard EVAR; therefore, a proper training system under a skilled supervisor needs to be established for endovascular teams.

The limitations of this study include the small sample size and the short follow-up period for the evaluation of the effectiveness of this procedure. Further investigation with a longer follow-up is necessary to evaluate the patients for late type III endoleak.

CONCLUSION

Five patients with JAAs underwent FEVAR using a Cook fenestrated stent-graft. Seventeen visceral vessels were accommodated with 12 fenestrations for renal arteries and 2 SMAs, and with 4 scallops for the left gastric artery, common hepatic artery, celiac artery, and 2 SMAs. Completion angiography showed a type III endoleak in 1 patient at a renal artery fenestration; this endoleak resolved by the 1-months postoperative CT scan. During the short-term follow-up study, occlusion of a distal component leg, which was placed inside the conduit graft, occurred in 1 case because of a graft kink; this condition was successfully treated with thrombectomy and deployment of an additional leg-device.

From this preliminary study, we conclude that the use of the Cook fenestrated stent-graft is feasible for the repair of JAAs in high-risk Japanese patients. This procedure may be a viable alternative for the treatment of JAA in the future. Further studies and data collection are required to test the usefulness of this technique across other Asian countries, with the device being designed and manufactured on the basis of a more detailed understanding of the unique anatomical characteristics of Asians.

DISCLOSURE STATEMENT

Dr. Unno and the other co-authors have no conflicts of interest to declare.

REFERENCES