Although the clinical usefulness of open surgery for thoracic and abdominal aortic aneurysms has been established, the morbidity and mortality rates of open surgery for the thoracic aorta remain high. In recent years, endovascular stent-graft repair (EVR) of both thoracic and abdominal aortic disease has been a technical advance; EVR is a minimally invasive technique and appears to be a relatively safe alternative to traditional open repair, particularly in high-risk patients. Outside Japan, various stent-graft (SG) device systems developed by several different companies have been approved and are already in clinical use, and numerous clinical results have been reported. In Japan, a surgical fee for EVR was listed in the Japanese health insurance system in 2002, in recognition of the clinical usefulness of the treatment. However, currently, none of the commercially available SGs have been approved, and all are at the multicenter clinical trial stage. Hence, only handmade devices produced at individual medical institutions are being tested and thus, the number of institutions that can consistently perform EVR is limited, and the quality of materials and the procedure used at each institution are varies. The clinical results are also influenced by the different indications and techniques.

At the Department of Surgery, Kurume University School of Medicine, we have designed and constructed a SG using stainless steel Z-stents that were covered with an ultrathin-wall woven polyester fabric. These handmade SGs were used to repair thoracic and abdominal aortic disease in high-risk patients. In this study, we examine the initial and midterm results obtained after repair of the aortic diseases using handmade SGs were considered to be satisfactory. More surgical experience and long-term patient follow-up are both required to further reassess the effect of this treatment. (Circ J 2006; 70: 726–732)

Key Words: Abdominal aorta; Endovascular repair; Handmade stent-graft; Thoracic aorta

### Methods

**Patients**

The subjects of this study were 41 patients (35 males, 6 females; mean age 71±10 years (range, 27–85)) who had undergone EVR using handmade SGs at the Department of Surgery, Kurume University School of Medicine between May 1999 and March 2004, after the approval of the Ethics Committee of Kurume University School of Medicine and the subjects gave informed consent. The mean follow-up period was 24.8±17.6 months (range, 0.3–60.4 months).

**Etiology**

EVR was performed in 31 patients with thoracic aortic diseases: 23 cases of degenerative aneurysms (1 rupture, 1 aorto-esophageal fistula), 6 cases of chronic dissection, and 2 of trauma. Emergency EVR was performed in 4 patients (1 rupture, 1 aorto-esophageal fistula, 2 traumatic injuries).

### Table 1  Etiology and Type of Lesion in Aortic Diseases

<table>
<thead>
<tr>
<th></th>
<th>Thoracic aorta</th>
<th>Abdominal aorta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total, n</td>
<td>31</td>
<td>10</td>
</tr>
<tr>
<td>Degenerative, n</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>Dissection, n</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Trauma, n</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

(Received September 16, 2005; revised manuscript received March 6, 2006; accepted March 14, 2006)
The 10 patients with abdominal aortic disease comprised 8 infrarenal degenerative aneurysms and 2 chronic dissections (1 iliac artery) (Table 1). EVR was not performed in patients with Marfan’s syndrome or vasculitis.

**Patient Characteristics**

The most common comorbidity was hypertension in 32 patients (83%), followed by chronic obstructive pulmonary disease (COPD) in 9 (22%), chronic renal insufficiency in 9 (22%), cerebrovascular disease in 6 (15%), diabetes mellitus in 6 (15%), hyperlipidemia in 4 (10%), and steroid therapy in 2 (5%). Malignancy during hospitalization occurred in 3 patients (7%), 16 (39%) had previously undergone a thoracotomy or laparotomy, and 18 patients (44%) were more than 75 years old (Table 2).

**Materials**

The SGs were constructed using Gianturco self-expandable stainless steel Z-stents (Cook Incorporated, Bloomington, IN, USA) covered with an ultrathin-wall woven polyester fabric (thickness, 0.1 mm; porosity, 200–250 ml·mm⁻²·min⁻¹·(120 mmHg)⁻¹; Ube Industries Ltd, Yamaguchi, Japan). The size of the SG was 10–20% greater than the diameter of the proximal and distal necks. In cases where the diameters of the proximal and distal necks differed considerably, the graft was modified by tapering in order to maintain the diameter within range. The shape of the SG for the thoracic region was tubular, whereas for abdominal aortic diseases it was either aortouniiliac or tubular.

The flexible SGs were used between May 1999 and April 2001, and the individually designed SGs between May 2001 and March 2004. The flexible SG was able to follow the contour of any aorta; that is, it could be curved in any direction. The individually designed SG was constructed by connecting the peaks of the stents with struts, and the stent was shaped such that it achieved a relatively rigid great curvature that conformed to the contour of the individual aorta (Fig 1).

**Procedure**

All procedures were performed in an operating room and in principle under general anesthesia (the procedure was performed under epidural anesthesia in 1 patient). The SG was inserted into an 18–22Fr (inner diameter) Teflon sheath, which transported the SG to the target zone, and was inserted via a surgically exposed femoral or iliac artery, or the abdominal aorta. Between 1999 and 2001, the SG was pushed from the tail region of the Teflon sheath by the inner tube; however, after 2001, a preloading method was frequently used wherein the SG was housed at the tip of the Teflon sheath in advance. In both methods, heparin (50–100 IU/kg bodyweight) was administered systemically in order to maintain the activated clotting time at 200 s or more, and the Teflon sheath was inserted with the guidance of a long guidewire (0.32 inch, 400 cm) that was introduced into the femoral artery through the right or left brachial artery (tug-of-wire method). These procedures were monitored by a portable radiographic C-arm system that was capable of producing high-resolution X-ray fluoroscopy and arteriography results. After implantation, the SG was gently dilated by balloon catheter, and an aortogram was obtained, using a pigtail catheter to confirm accurate positioning. Transesophageal echocardiography was used to observe the procedure during EVR for thoracic lesions. If an endoleak was observed, an additional SG was placed proximally or distally in order to ensure aneurysmal exclusion.

When an SG was deployed in a thoracic aortic lesion, migration of the SG because of the blood flow during deployment was prevented by temporary cardiac arrest attained by an intravenous injection of 0.2–0.4 mg/kg adenosine triphosphate immediately prior to the release of the device, under pacing catheter insertion.

When aortouniiliac SGs were used to treat an abdominal aortic lesion, the iliac artery on the opposite side was occluded and femoro/external iliofemoral artery cross-over bypass surgery was conducted simultaneously.

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**Table 2 Patient Characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>32</td>
<td>83</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>9</td>
<td>22</td>
</tr>
<tr>
<td>Chronic renal insufficiency</td>
<td>9</td>
<td>22</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>4</td>
<td>10</td>
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<tr>
<td>Steroid therapy</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Cancer</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Previous thoractomy and/or laparotomy</td>
<td>16</td>
<td>39</td>
</tr>
<tr>
<td>More than 75 years old</td>
<td>18</td>
<td>44</td>
</tr>
</tbody>
</table>

---

Fig 1. The flexible stent-graft (SG) is able to follow the contour of any aorta; that is, it can be curved in any direction. The individually designed SG was constructed by connecting the peaks of the stents with struts, and the stent was shaped such that it achieved a relatively rigid great curvature that conformed to the contour of the individual aorta.
Definitions

The size of the aneurysmal sac was defined as the minor axis on the largest axial cut of the aneurysm on 2-dimensional (D) computed tomography (CT) scan. The proximal or distal neck angulation was determined by measuring the angle from the long-axis line of the aorta using 3-D CT or digital subtraction angiography (DSA).

After the procedure, all patients underwent CT scan prior to discharge, and at 1, 3, 6, 12 months, and annually thereafter (Fig 2). A decrease or increase in the maximum aneurysmal diameter by 5 mm or more from the baseline scan at any follow-up time point was considered to be a significant change in the size of the aneurysm.

Type I, II, III or IV endoleak, or migration was diagnosed by CT, DSA, or ultrasound imaging.

The following criteria defined technical success.
1. Successful access to the arterial system by using a remote artery (ie, the femoral, external iliac, and common iliac arteries with or without using a temporary or permanent prosthetic conduit to access these arteries).
2. Successful deployment of the SG with secure proximal and distal fixation.
3. Absence of either a type I or III endoleak.
4. A patent SG without significant twists, kinks, or obstructions.

Clinical success was defined as successful deployment of the SG to the intended location without resulting in death of the patient from aneurysm-related treatment, type I or III endoleak, migration, graft infection or thrombosis, aneurysm expansion, aneurysm rupture, or conversion to open repair.

Table 3 Initial and Midterm Success Rates

<table>
<thead>
<tr>
<th></th>
<th>Initial results, % (n)</th>
<th>Midterm results, % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Technical success</td>
<td>Initial clinical success</td>
</tr>
<tr>
<td>All</td>
<td>82.9 (34/41)</td>
<td>80.5 (33/41)</td>
</tr>
<tr>
<td>Thoracic</td>
<td>80.6 (25/31)</td>
<td>77.4 (24/31)</td>
</tr>
<tr>
<td>Abdominal</td>
<td>90.0 (9/10)</td>
<td>90.0 (9/10)</td>
</tr>
</tbody>
</table>

The proximal landing zone of the SG for the thoracic aorta was classified according to the zone map proposed at the First International Summit on Thoracic Aorta Endografting held in Tokyo in March 2001. The SG at landing zone Z0 was partially fenestrated to preserve the brachiocephalic artery and left common carotid artery.

Indications

The anatomical indications for EVR were defined as a landing zone length of 20 mm or more, a diameter of 36 mm or less, angulation of less than 60 degrees, and no obvious parietal thrombus or atheroma in the arterial wall at the landing zone.

In our department, conventional open surgery is the first choice of surgical treatment for thoracic and abdominal aortic diseases. However, open surgery can be extremely difficult to perform when the patient has a history of comorbidities, poor general condition, or a history of thoracotomy and/or laparotomy, in which case EVR is clinically indicated, or if the patient does not consent to open surgery and strongly requests EVR.

Furthermore, even if open surgery could be performed for comparatively easy conditions, such as descending aortic aneurysms, EVR was used to treat these cases because it is less invasive, and hence advantageous. If open surgery had to be abandoned, EVR was performed even if the anatomical indications for EVR were not met.

Statistical Analysis

The data are expressed as the mean ± standard deviation. The Kaplan-Meier method was used to evaluate the clinical success rates.

Results

Initial Results of All Patients

The technical success rate among all cases was 82.9% (34/41) (Table 3). Among the 7 unsuccessful cases (6 thoracic, 1 abdominal), iliac artery intimal dissection in the access route occurred in 1 patient during the procedure. This patient underwent graft replacement of the iliac artery, and EVR was not performed on the same day. In the other 6 patients, although the SG could be placed in the target...
Deployment-related complications occurred in 3 patients. Therefore, the hospital mortality rate was 4.9% (2/41).

The other patient had a superior mesenteric venous thrombosis, grade 3 in 1 patient) (Table 4).

The proximal landing zone of the SG was Z0 in 5 patients, Z1 in 0, Z2 in 2, Z3 in 9, and Z4 in 15. Type I endoleaks occurred during the procedure in 1 Z2 patient, 2 Z3 patients, and 2 Z4 patients. EVR was performed in the 2 Z3 patients, achieving primary entry closure of a chronic type B aortic dissection, but not complete closure. In the 2 Z4 patients, the proximal landing zone was the prosthetic graft and a proximal type I endoleak occurred. Endoleaks or other complications did not occur in the 4 patients who underwent emergency EVR. Stroke or paraplegia did not occur. Technical and initial clinical success rates for EVR of thoracic aortic diseases were 80.6% (25/31) and 77.4% (24/31), respectively (Table 3).

There were 7 aortouniiliac SGs and 3 tubular SGs. The proximal landing zone for all grafts was infrarenal. The SG was successfully deployed to the intended target zone in all patients; however, 2 endoleaks (type I and II) occurred. Of the other 5 deaths, 2 were from cancer, 1 from cerebral infarction, 1 from pneumonia, and 1 from a graft-to-duodenum fistula following abdominal aortic bypass surgery.

Migration and Open Conversion Five patients (12.2%) had to undergo graft replacement during follow-up. Of these, replacement had to be performed in 2 patients (1 descending thoracic aorta, 1 abdominal aorta) because of SG migration (4.9%) (Table 5) into the aneurysmal sac during follow-up. Transaortic SG placement after a median sternotomy was performed in the 2 patients who had undergone EVR for chronic type B aortic dissections and in whom complete primary entry closure was not achieved. In the fifth case, a patient who had undergone emergency EVR for a distal arch aortic aneurysm that had penetrated the esophagus, signs of infection of the SG were observed after 5.3 months and therefore, graft replacement and an esophageal transaction, as well as secondary reconstruction of the esophagus, were performed. The patient was discharged from the hospital without any complications.

Persistent Endoleak Persistent endoleaks occurred in 5 patients (4 type I and 1 type II) during the follow-up period (Table 5). Of the 2 cases of type I endoleak, 1 died because of an aneurysm rupture and other from cancer. Open conversion was performed in 2 of the other patients, and the patient with the type II endoleak was conservatively followed because there were no changes in the aneurysm diameter. The development of a new endoleak after discharge from the hospital (secondary endoleak) occurred in only 1 patient (2.6%) with SG migration who had undergone EVR for the descending aorta. Failure of the SG because of fracture of the stent or graft perforation was not observed. Type III or IV endoleaks were not identified in any cases.

Aneurysm Diameter Postoperative CT scans were performed in 35 patients to confirm the diameter of the aneurysms. The mean duration from the procedure until the final CT scan was 15.7±12.8 months (range, 0.3–60.4 months) and the mean change in the aneurysm diameter was –6.2±10.5 mm (range, –34 mm to +13 mm). A decrease in the diameter occurred in 18 of the 35 patients (51.4%), no change in 14 (40.0%) cases and an increase in 3 (8.6%) (Table 5). Of those 3 patients, 1 died from aneurysm rupture, and the remaining 2 patients underwent open surgery.

Table 4 Initial Clinical Results

<table>
<thead>
<tr>
<th></th>
<th>Thoracic, n=31</th>
<th>Abdominal, n=10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsuccessful access</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Unsuccessful deployment</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Endoleak</td>
<td></td>
<td></td>
</tr>
<tr>
<td>During procedure</td>
<td>Proximal type I, 5</td>
<td>Distal type I, 1</td>
</tr>
<tr>
<td>Primary</td>
<td>Proximal type I, 4</td>
<td>Distal type I, 1</td>
</tr>
<tr>
<td></td>
<td>Type II, 1</td>
<td></td>
</tr>
<tr>
<td>Deployment-related complication</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Systemic complication</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>In hospital death</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 5 Midterm Clinical Results

<table>
<thead>
<tr>
<th></th>
<th>Thoracic, n=29</th>
<th>Abdominal, n=10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent endoleak</td>
<td>Proximal type I, 4 Type II, 1</td>
<td></td>
</tr>
<tr>
<td>Secondary endoleak</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Migration</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Open conversion</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Aneurysm diameter (n=35)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Increase</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Aneurysm rupture</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Related death</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Midterm Results

Mortality Of the 41 patients, 39 survived and were discharged from the hospital; however, 6 died during the follow-up period (1 related death (2.6%), 5 from other causes). In the case of related death after discharge (Table 5), EVR was performed to treat an aneurysm in the region of the anastomosis following graft replacement for a thoracic aortic aneurysm. A proximal type I endoleak occurred, and enlargement of the aneurysm was confirmed at 27.5 months. However, the patient refused further surgical treatment. The aneurysm ruptured 36.5 months after the procedure. Of the other 5 deaths, 2 were from cancer, 1 from cerebral infarction, 1 from pneumonia, and 1 from a graft-to-duodenum fistula following abdominal aortic bypass surgery.
There were no endoleaks or migration of the SG in the 11 patients in whom the diameter of the aneurysm remained unchanged, and they are being conservatively followed.

**Clinical Success Rate During Follow-up**

Successful deployment of the SG at the intended location that did not result in death from aneurysm-related treatments, type I or III endoleak, migration, graft infection or thrombosis, aneurysm expansion, aneurysm rupture, or conversion to open repair occurred in 32 cases. The overall clinical success rate during follow-up was 78.0% (32/41). The clinical success rate was 74.2% (23/31) in patients with thoracic aortic disease and 90.0% (9/10) in patients with abdominal aortic disease (Table 3). The Kaplan-Meier curve of the clinical success in all 41 patients was 86.9% at 12 months (Fig 3).

**Discussion**

The number of cases undergoing EVR is steadily increasing, and favorable midterm results have been reported.\(^3\)–\(^11\) Furthermore, the development of devices, expansion of indications, and improved clinical results with regard to EVR are anticipated. Particularly in the case of thoracic aortic diseases, EVR offers the theoretical advantage of being minimally invasive compared with conventional open surgery under cardiopulmonary bypass.\(^12\)–\(^14\) In the present study, there were no cases of stroke or paraplegia after EVR of the thoracic aorta, and no perioperative complications occurred after EVR of the abdominal aorta. The morbidity and mortality rates associated with EVR as a treatment are appropriate considering the fact that it was performed in several types of high-risk patients, such as elderly patients, patients with COPD, those on long-term steroid medication, those who have previously undergone a thoracotomy or laparotomy, or those who have sustained trauma or rupture. However, even when EVR is performed successfully, there can be complications, other than those encountered with conventional surgery. Endoleak, migration, or aneurysm expansion can accompany EVR, and it is difficult to prevent these complications using the currently available devices. Thus, the patient is at double risk; the first is the procedure itself and the second is SG-related complications during the long-term follow-up period. Furthermore, reports on the clinical results vary among institutions and differ according to the type of device used. Reports on handmade SGs are limited, and the results in these cases are unknown.\(^15\)–\(^23\)

In Japan, EVR devices have not been approved as medical devices thus far. Therefore some medical institutions produce their own handmade SGs, and compared with other countries, only a small number of patients undergo this procedure in Japan. Each institution has been designing devices and establishing indications that are largely based on trial and error. Hence, both the materials used to prepare the SGs and the procedure followed for EVR vary, and the clinical results are influenced by the institutional indications and techniques.\(^1\)–\(^16\)\(^–\)\(^20\)

Our department has been producing and using SGs that comprise stainless steel Z stents and are covered with an ultrathin-wall woven polyester fabric. The initial and midterm results for repair using these handmade SGs for thoracic and abdominal aortic diseases in high-risk patients are considered to be satisfactory.\(^3\)–\(^11\), \(^24\)–\(^30\) However, endoleaks were the reason for poor initial results, whereas the reason for poor midterm results was migration. Furthermore, all endoleaks and migrations occurred during the early phase of surgeries using flexible SGs that were designed on the basis of a concept identical to the commercially available SGs wherein 1 device can be used to treat various aortic contours. Continuous downward displacement forces are exerted on all aortic devices by the pulsatile blood flow, with cumulative effects over time.\(^31\) These forces cause a kink in the greater curvature of the SG, which leads to migration of the SG into the aneurysmal sac. However, establishing a hook, barb, or bare stent in the landing zone to prevent an endoleak or migration\(^32\)–\(^34\) may potentially injure the aortic wall or occlude an aortic branch. Although the feasibility of EVR for aortic dissections using simple cylindrical SGs has been reported,\(^35\)–\(^38\) transformation, kinking, and fragility of the true lumen are associated with the risk of intima damage or endoleak. We encountered endoleaks in the case of aortic dissections and prosthetic proximal landing zones. It was necessary to improve the SG devices to prevent these SG-related complications. Therefore, we changed the design of the SG such that it could be accurately attached to the aortic wall. In addition, we constructed it in such a manner that it could not be easily dislodged by the pulsatile force of the blood flow and not injure the aortic wall. We devised SGs that could follow the contour of different aortas to the maximum possible extent for individual patients. The individually designed SG was constructed by connecting the peaks of the stents with struts, and the stent was shaped such that it achieved a relatively rigid great curvature, and conformed to the contour of the individual aorta. When an individually designed SG was used, there was no incidence of endoleaks, secondary endoleak, migration or the need for a secondary procedure. In addition, related complications and deaths, aneurysm expansion, or surgical conversion did not occur during the follow-up period. Alteration of the SGs yielded good results in the later surgeries. Saito et al\(^20\) reported the feasibility of EVR for thoracic aortic diseases using an Inoue single-branch SG. They used a specialized computer system for designing custom-made SGs for individual patients, and similar systems will be required to modify the commercially available SGs. If we consider our experience with handmade SGs, it is possible to achieve appropri-
ate results with EVR using commercially available SGs. However, the following problems persist with respect to handmade SGs. First, the device has to be designed or developed to prevent migration and achieve an increase in the proximal and distal landing, either physically or chemically. Malina et al.\textsuperscript{53} have reported that endografts prepared from woven Dacron detach easily from the aortic wall and do not heal strongly within the human aortoiliac vessels 9 months after insertion. They showed that a perigraft space with loosely arranged blood cells persists for several years. In addition, based on improvements in commercially available SG devices, there is a need to establish anatomical indications and an oversized range of SG in the case of handmade SGs.\textsuperscript{39–42} Second, it is difficult to treat emergency cases, such as ruptures, acute dissections, and traumatic injuries, with handmade SG. Excellent results have been reported for commercially available SGs, which have a narrow and flexible delivery system and can be used in emergency cases.\textsuperscript{33–47} Although Kato et al.\textsuperscript{48} have reported the feasibility of EVR using handmade SGs for blunt aortic injury, it is disadvantageous compared with using commercially available SGs because of the time required to produce the SG using 3D-CT scans and angiography, which are conducted prior to the procedure. It is necessary to devise handmade SGs that can be used in emergency cases because then EVR could be used at least as a temporary treatment prior to surgical repair or as a therapeutic alternative in critically ill patients, such as those with ruptured, traumatic, or mycotic aneurysms.\textsuperscript{39} Third, it is difficult to produce a bifurcated SG for the treatment of abdominal aortic aneurysms, and hence an aortouniliac SG placement with femorofemoral bypass graft occlusion did not occur; however, it should be noted that this procedure is an anti-anatomical bypass if it offers an encouraging median and long-term patency.\textsuperscript{50,51} Fourth, the long-term results of EVR using handmade SGs are unknown. Although there were no material failures with the handmade SGs during the follow-up period, material failures in commercially available SGs have been reported.\textsuperscript{52–55} If handmade SGs are constructed from a stainless steel stent welded using solder and covered by a hand-sutured ultrathin woven fabric, may show material failure in the long term. In addition, the possibility of endoleak and/or migration in the future cannot be ruled out because the number of patients in this study was small and the follow-up period was short.\textsuperscript{56,57}

**Conclusion**

The initial and midterm results obtained for EVR using handmade SGs for thoracic and abdominal aortic diseases were satisfactory. However, it is necessary that we acquire more experience and conduct more long-term patient follow-up to reassess the effect of this treatment. In the future, we must take into account the experience of handmade SG repair while modifying commercially available SGs.

**References**


