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ORIGINAL ARTICLE

SEALING ZONE ISSUES IN DIFFERENT PARTS OF THE AORTA POST-ENDOVASCULAR REPAIR

Mid-term proximal sealing zone evaluation after fenestrated endovascular aortic aneurysm repair

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ABSTRACT

BACKGROUND: Fenestrated endovascular aortic aneurysm repair (FEVAR) is used in pararenal abdominal aortic aneurysms to achieve a durable proximal seal. This study investigated the mid-term course of the proximal fenestrated stent graft (FSG) sealing zone on the first and latest available post-FEVAR computed tomographic angiography (CTA) scan in a single-center series.
METHODS: In 61 elective FEVAR patients, the shortest length of circumferential apposition between the FSG and the aortic wall (shortest apposition length [SAL]) was retrospectively assessed on the first and last available postoperative CTA scans. Patient records were reviewed for FEVAR-related procedural details, complications, and reinterventions.
RESULTS: The median (interquartile range) time between the FEVAR procedure and the first and last CTA scan was 35 (30-48) days and 2.6 (1.2-4.3) years, respectively. The median (interquartile range) SAL was 38 (29-48) mm, and 44 (34-59) mm on the first and last CTA scans, respectively. During follow-up, the SAL increased >5 mm in 32 patients (52%), and decreased >5 mm in six patients (10%). Reintervention was performed for a type 1a endoleak in one patient. Twelve other patients needed 17 reinterventions for other FEVAR-related complications.
CONCLUSIONS: Good mid-term apposition of the FSG in the pararenal aorta was achieved post-FEVAR, and the occurrence of type 1a endoleaks was low. The number of reinterventions was substantial, however, but for reasons other than loss of proximal seal.

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KEY WORDS: Abdominal aortic aneurysm; Endovascular aneurysm repair; Prostheses and implants; Three-dimensional imaging.

Fenestrated endovascular aortic aneurysm repair (FEVAR) is the preferred treatment for patients with a pararenal abdominal aortic aneurysm (pAAA).[1] The number of fenestrations needed for the fenestrated stent graft (FSG) configuration depends on the extent of the proximal landing zone. During the past decade, FEVAR with single (1-) or double (2-) FSG configurations has shifted to FEVAR with triple (3-) or quadruple (4-) FSG configurations to further extend the proximal sealing zone.[2, 3]

Lifelong yearly imaging surveillance is recommended post-FEVAR for patients because endoleaks and stenosis or occlusion of the (bridging) stent grafts may develop. Sufficient proximal sealing zone of the FSG is essential for successful aneurysm treatment and durable FEVAR outcome. The proximal sealing zone can be assessed by determination of circumferential apposition between the FSG and the aortic wall on standard post-FEVAR computed tomographic angiography (CTA) scans. A seal of <10 mm or decreasing circumferential apposition has been shown to be indicative for the development of a type 1a endoleak in patients who have undergone EVAR.[4, 5] The same applies for patients who have been treated with FEVAR, apposition is however not regularly assessed on post-FEVAR CTA scan reports. Literature shows that an expert opinion of 11 vascular surgeons agreed on determination of the course of postoperative sealing zone after EVAR.[6]

The present study investigated the course of apposition of the proximal FSG on the first and latest available postoperative CTA scans and its association with FEVAR-related complications.

Materials and methods

This retrospective observational study investigated patients electively treated for a pAAA with a primary FEVAR or with FEVAR to rescue a previous failed EVAR. In a fusiform pAAA, indication for FEVAR was a diameter >5 cm. Treatment for a pAAA <5 cm was only performed in case of a saccular aortic aneurysm or to treat a concomitant common iliac artery aneurysm >3.5 cm. Only patients treated with a Zenith (Cook Medical Inc., Bloomington, IN, USA) FSG were included. All patients were consecutively treated between January 2012 and December 2019 in the University Medical Center Groningen (UMCG).

For inclusion into this study, all patients were required to have at least two postoperative CTA scans that included the entire proximal part of the FSG: one CTA scan within 3 months after the FEVAR procedure (first CTA scan) and a second CTA scan thereafter. In case of multiple postoperative CTA scans, the latest available (last) CTA scan during follow-up was used for the imaging analysis. Exclusion criteria were treatment for aortic dissections, symptomatic pAAAs or rupture, use of additional proximal fixation (*e.g.*, endoanchors or thoracic extension cuff), and endovascular treatment of the thoracic aorta in the past with overlap of the FSG.

The patients' demographics and clinical outcome data, as available until August 2022, were retrospectively collected from the electronic patient records and registered in a Research Electronic Data Capture (REDCap v. 8.10.18; Vanderbilt University, Nashville, TN, USA). Patient records were reviewed for preoperative aneurysm diameter, FEVAR procedural details, including FSG configuration, and the proximal end of the fabric related to the endomarkers, periprocedural data, postoperative imaging examinations, post-FEVAR complications, and reinterventions. The study was approved by the UMCG Institutional Review Board and was performed in accordance with the Declaration of Helsinki. Informed consent was waived according to institutional policy on retrospective research.

Scan protocol

The CTA scans were acquired on a Siemens Sensation 64 (Siemens Healthcare GmbH, Erlangen, Germany) until June 2017 and Siemens Definition EDGE CT scanner from June 2017 (Siemens Healthcare GmbH, Erlangen, Germany). Scan parameters were variable tube voltage according to the Care-kV protocol, or variable tube current according to the Care Dose 4D protocol, 0.8-mm pitch and 128×0.6-mm collimation, and 0.5-second rotation time. Per CTA scan, 100 mL (4 mL/s) diluted contrast (Iomeron 350; Imaging GmbH, Konstanz, Germany) was administered intravenously in the arterial phase. Images were reconstructed to a 0.75-mm slice thickness using a medium-smooth convolution kernel.

Measurement protocol

The shortest apposition length (SAL) over the circumference of the aorta was determined on the first and last CTA scans for each patient by means of a standardized and previously validated measurement protocol.[7] For patients with a type 1a endoleak, SAL was measured on all postoperative CTA scans up to the diagnosis of the type 1a endoleak.

Measurements were performed on a 3mensio vascular workstation (v. 10.2 SP2, Pie Medical Imaging BV, Maastricht, the Netherlands) by one of two readers (S.S. and C.R.) and confirmed by a second reader (R.S.). First, the lumen of the aorta was segmented, and a centerline was created semi-automatically with manual correction of misplaced center lumen points. Second, three-dimensional reference markers were placed. Four markers were placed at the proximal end of the FSG fabric. Four markers were placed at the orifices of the left renal artery (LRA) and right renal artery (RRA), superior mesenteric artery (SMA), and celiac trunk. One marker was placed at the distal end of circumferential apposition between the FSG and the aortic wall. Any fenestrations and scallops were included in the circumferential apposition of the FSG. The maximum aneurysm diameter was measured as the average of two orthogonal diameters from adventitia to adventitia at the centerline location of the largest diameter.

The segmentation of the aortic lumen, the centerline, and the reference markers were exported from 3mensio and loaded into Vascular Imaging Analysis (VIA) prototype software (Endovascular Diagnostics BV, Utrecht, the Netherlands) for assessment of the SAL (Figure 1). The SAL was defined as the shortest distance over the circum-

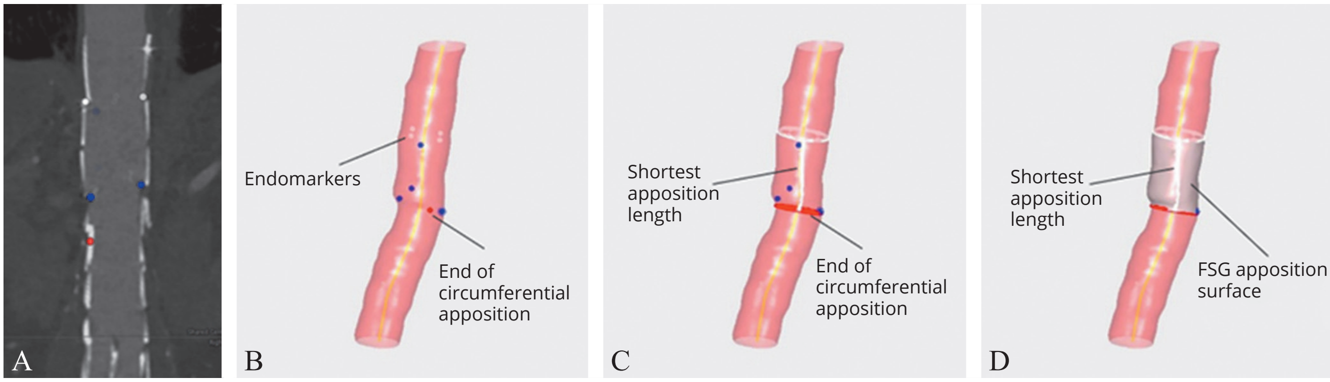

Figure 1.—Fenestrated stent graft (FSG) apposition measurements in 3mensio and apposition calculation in Vascular Image Analysis prototype software: A) placement of the reference markers on a stretched vessel view in 3mensio; B) aortic lumen segmentation with centerline, and reference markers of the four endomarkers of the FSG (white), the orifices of the renal arteries, superior mesenteric artery, and celiac trunk (blue), and the distal end of circumferential apposition (red); C) shortest apposition length (SAL) between the proximal end of the FSG and the distal end of circumferential apposition; D) circumferential apposition surface (white) of the FSG with the aortic wall.

ference of the aorta between the proximal end of the FSG fabric and the end of circumferential apposition, which was calculated automatically by the software.

Outcome measures

Shortest apposition length

The primary outcomes were differences in SAL between the first and last CTA scans. Three potential causes for decreasing apposition were defined (Figure 2), including: 1) distal migration of the FSG; 2) increase of the aortic diameter at the distal end of the apposition (due to aneurysm growth); and 3) increase of the aortic diameter at the proximal sealing zone (due to extension of disease). For patients with a >5-mm decrease of SAL, the cause was classified by two observers (C.R. and R.S.).

Assessment of postoperative complications

Secondary outcomes were FEVAR-related complications at any time during follow-up until August 2022. Radiology reports of postoperative CTA scans and duplex ultrasound (DUS) imaging were reviewed. FEVAR-related complications were defined as type 1a, 1b, 2, or 3 endoleak, fenestration-related endoleak (type 1c, 3c, and 3d), stenosis, occlusion, stent graft fracture, FSG migration, and stent graft infection.

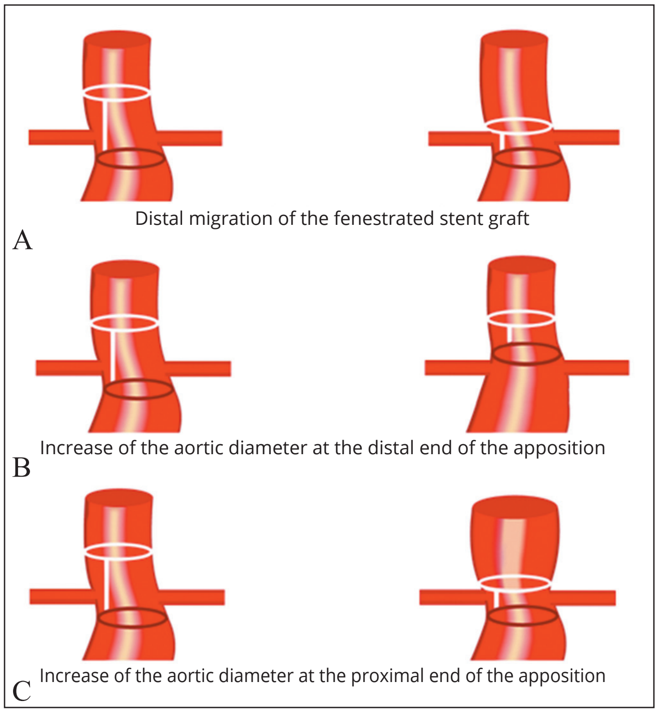

Figure 2.—Potential causes of shortest apposition length (SAL) decrease: A) distal migration of the fenestrated stent graft; B) decreasing apposition at the distal sealing zone (due to aneurysm growth); C) decreasing apposition at the proximal sealing zone (due to progressive increase of the aortic diameter).

Statistical analysis

Data were analyzed using SPSS 27 statistical software (IBM Corp, Armonk, NY, USA). Normality of the data was assessed via visual inspection of quantile-quantile plots. Normally distributed variables are expressed as mean and standard deviation, and skewed distributed variables are expressed as median (interquartile range). The difference in SAL between patients treated with a single or double FSG configurations and a triple or quadruple FSG configurations is tested with an independent samples *t*-test. A probability (P) value of <0.05 was considered indicative of statistical significance. The difference in maximum aneurysm diameter and the aortic neck diameter were correlated to the difference in SAL with the Pearson's correlation coefficient, where r ≥0.5 indicates a strong relationship.

Results

Study population

Between January 2012 and December 2019, 106 FEVAR procedures were performed in the UMCG. Nine of these 106 patients did not meet the inclusion criteria due to a FSG without a fenestration (single scallop, N.=1) or use of a FSG other than the Zenith FSG (N.=8). Another 36 patients were excluded because at least one of the required two postoperative CTA scans was missing (N.=27; 14 missed one CTA scan due to early death, 11 due to non-contrast CT and/or DUS surveillance because of pre-existent renal insufficiency, one due to follow-up in another hospital, and one due to too-short scan window), adjunct proximal fixation (N.=2; thoracic endograft cuff), and endovascular treatment of the thoracic aorta in the past with overlap of the FSG (N.=7). The remaining 61 FEVAR patients were included in the current analysis. Patient demographics are summarized in Table I.

FEVAR was used as primary treatment in 59 patients (97%), and two patients (3%) were treated with a fenestrated cuff for a type 1a endoleak after previous EVAR. The study population included four patients treated with a 1-FSG configuration, 15 patients with a 2-FSG configuration, 25 patients with a 3-FSG configuration, and 17 patients with a 4-FSG configuration.

The median time between the FEVAR procedure and the first CTA scan was 35 (30-48) days. The median time between the FEVAR procedure and the last CTA scan was 2.6 (1.2-4.3) years. The median total duration of CTA or DUS follow-up for assessment of postoperative complications was 3.6 (2.2-5.6) years.

Table I.—*Baseline characteristics of the 61 patients included in this imaging study.*

Variable	All patients (N.=61)
Age (years)	70.3±7.0
Male sex	50 (82%)
Hypertension (systolic blood pressure >140 mm Hg)	54 (89%)
Diabetes mellitus	11 (18%)
Coronary artery disease	30 (49%)
Chronic obstructive pulmonary disease	17 (28%)
Pre-FEVAR aneurysm diameter (mm)	57.4±10.0
American Society of Anesthesiologists score ≥III	38 (62%)

FEVAR: fenestrated endovascular aneurysm repair.
Continuous variables are shown as mean±SD and categorical variables as number (ratio).

SAL on the first postoperative CTA scan

The median SAL was 38 (29, 48) mm on the first CTA scan (Figure 3). For 19 patients with 1- or 2-FSG configurations, median SAL was 28 (25-32) mm *versus* 42 (33-51) mm for 42 patients with 3- or 4-FSG configurations (P<0.001).

The SAL was <10 mm on the first CTA scan of three patients (5%):

- there was no apposition in one patient due to circumferential aortic thrombus load in the aortic wall at the proximal sealing zone, but no type 1a endoleak was visible. The last CTA scan 7.5 years after the FEVAR procedure reported extension of disease. A renewed intervention was not performed because of severe comorbidity, and this patient died;
- the SAL was 6 mm on the first CTA scan, without a type 1a endoleak, and increased to 43 mm on the last CTA scan 2 years post-FEVAR due to aneurysm shrinkage including the proximal side of the aneurysm, and thus the distal side of the aortic neck;
- the SAL was 9 mm on the first CTA scan, without

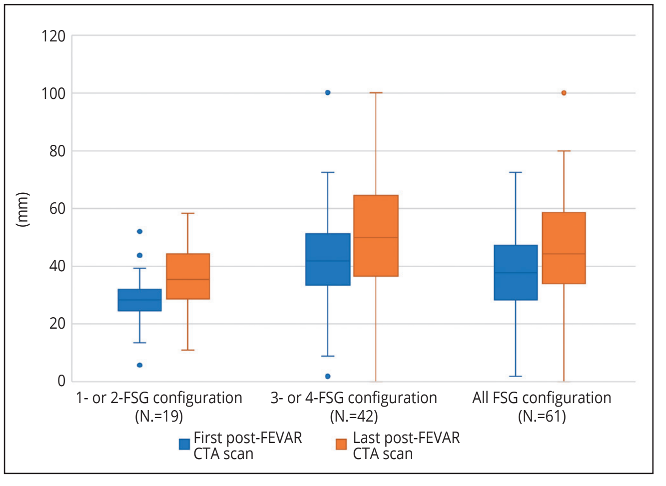

Figure 3.—Shortest apposition length for patients treated with single or double fenestrated stent graft (FSG) configurations, and patients with three- or four-FSG configurations on the first and last computed tomographic angiography (CTA) scan after fenestrated endovascular aneurysm repair (FEVAR). The horizontal line in the middle of each box indicates the median; the top and bottom borders of the box mark the 75th and 25th percentiles, respectively, the whiskers mark minimum and maximum of all the data and is limited by the third quartile plus 1.5 times the interquartile range; and circles indicate outliers.

a type 1a endoleak, and increased to 41 mm on the last CTA scan 3 years post-FEVAR due to aneurysm shrinkage including the proximal side of the aneurysm, and thus the distal side of the aortic neck.

SAL on the last postoperative CTA scan

The median SAL was 44 (34-59) mm on the last CTA scan (Figure 3). For 19 patients with 1- or 2-FSG configurations, the median SAL was 35 (29-44) mm *versus* 50 (37-65) mm for 42 patients with 3- or 4-FSG configurations (P<0.001).

The SAL was <10 mm on the last CTA scan in two patients (3%):

• the patient with circumferential thrombus in the juxtarenal neck, which was described above;

• the SAL diminished from 21 to 0 mm during 4.1 years of follow-up. On the previous follow-up CTA at 3.3 years, the SAL had been stable (21 mm). During follow-up, fenestration-related endoleaks of the LRA and SMA were reported and successfully treated 2.5 years after the FEVAR procedure. A fenestration-related endoleak of the celiac trunk in combination with a fractured bridging stent graft, and a type 2 endoleak were reported and successfully treated 4.1 years after the FEVAR procedure. On the last CTA scan, a type 1a endoleak was observed. Endovascular reintervention with endoanchors was performed 4.4 years after the FEVAR procedure, but this was unsuccessful. Therefore, another reintervention with extensive embolization of the accessory left renal artery in continuation with the proximal sealing zone with multiple Interlock coils and Histoacryl was performed 4.8 years after the FEVAR procedure. Despite multiple reinterventions, the type 1a endoleak persisted and this patient died of aortic rupture.

Evaluation of SAL during follow-up

The median change of SAL was 5 (-2 to 14) mm. The SAL increased >5 mm in 32 patients (52%), and decreased >5 mm in six patients (10%). Potential causes of the SAL decrease in these six patients are listed below.

Distal migration of the FSG:

• the SAL was 29 mm on the first CTA scan and decreased to 23 mm during 3 years of follow-up (Figure 4A). Migration of the FSG led to a crushed bridging stent graft and fenestration-related endoleak of the LRA. Furthermore, a type 1b and 2 endoleak were also diagnosed. On the last CTA scan, a FSG-related infection was also diagnosed. The patient was unfit for open surgery and died 1 month later.

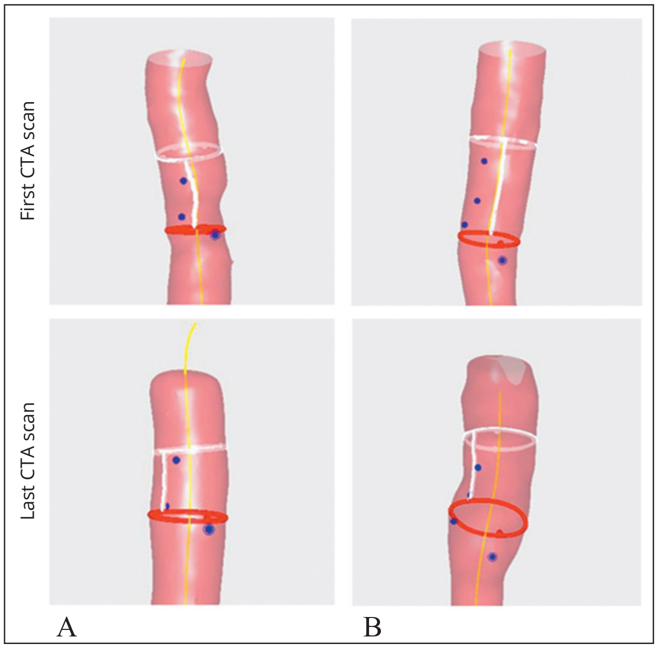

Figure 4.—Visualization of two causes of decrease of shortest apposition length (SAL) on postoperative follow-up scans after fenestrated endovascular aortic aneurysm repair: A) SAL decrease due to distal migration of the fenestrated stent graft (FSG); B) progressive increase of the aortic diameter at the distal end of the apposition.

SAL decrease at the distal sealing zone:

• the SAL was 49 mm on the first CTA scan and decreased to 37 mm during 5 years of follow-up (Figure 4B), due to a complex type 2 endoleak, and embolization was scheduled;

• the SAL was 42 mm on the first CTA scan and decreased to 37 mm during 3 years of follow-up. No endoleaks or other complications were reported;

• the SAL was 29 mm on the first CTA scan and decreased to 23 mm during 2 years of follow-up. This patient had a type 2 endoleak and a fenestrated-related endoleak of the LRA, for which a reintervention was performed;

• the SAL was 19 mm on the first CTA scan and decreased to 11 mm during 6 years of follow-up. No endoleaks or other complications were reported;

• the patient with a type 1a endoleak, which was described above.

None of the patients in this data set had a decrease of seal due to aortic dilatation at the proximal landing zone.

No correlation was found between the difference in SAL and the difference in maximum aneurysm diameter (r=-0.01; P=0.955) or the aortic neck diameter (r=-0.01; P=0.932).

Postoperative outcomes

For 30 patients, there were 48 FEVAR-related complications reported in Table II. There were 18 reinterventions performed for 13 patients, three of whom underwent multiple reinterventions. The indications for the post-FEVAR reinterventions are summarized in Table III. The outcome of the reintervention was successful for 16 out of 18 (89%) reinterventions. The median time between the FEVAR procedure and the first reintervention was 1.3 (0.4, 2.3) years.

Five reinterventions were performed in the cohort of 19 patients (26%) with a 1- or 2-FSG configuration and 13 reinterventions in the cohort of 42 patients (31%) with a 3- or 4-FSG configuration. Two of 34 fenestrations (6%) of 19 patients treated with a 1- or 2-FSG configuration reported a fenestration or BECS complication *versus* 14 of 143 fenestrations (10%) in the 42 patients treated with a 3- or 4-FSG configuration.

Discussion

This single-center retrospective study shows that during mid-term follow-up post-FEVAR, a decrease of proximal apposition of the FSG in the pararenal aorta is rare. The number of type 1a endoleaks was also low, as was migration of the FSG as a cause of diminishing proximal seal. The need for reinterventions, however, is substantial but related to other FEVAR complications. No correlation was found between the difference in maximum aneurysm diameter and the difference in SAL. This can be explained by the fact that SAL will only increase if aneurysm sac shrinkage occurs at the proximal side of the aneurysm and/or distal side of the aortic neck. Therefore, a decreased maximum aneurysm diameter does not necessarily result in an increased SAL.

Annual imaging follow-up has been regarded as mandatory for FEVAR patients.[8] The absence of endoleaks and aneurysm shrinkage can be verified with DUS, however proximal seal length and the origin of an endoleak, can only be assessed on CTA scans. This study shows >10 mm apposition for almost all FEVAR patients on the first and last CTA and a low occurrence of type 1a endoleaks. Literature also reported a low incidence of type 1a endoleak until 5 years of follow-up post-FEVAR.[9] Therefore, whether an annual CTA scan is necessary is debated. DUS is less expensive, and the patient is not exposed to radiation or contrast. In case of an endoleak or aneurysm growth on DUS, an additional CTA scan can be performed. If a CTA is indicated, maximum information should be obtained. Precise FSG analysis, including apposition measurements and geometry analysis of (bridging) stent grafts in the fenestrations, can be helpful in determining the underlying cause of FEVAR-related complications.[10] This is also valuable information to guide a reintervention.

Table II.—*Postoperative complications.*

Complication	N. (N.=48)
Type 1a endoleak	1
Type 1b endoleak	3
Type 2 endoleak	18
Type 3 endoleak	1
Fenestration-related endoleak	5 (4× LRA and 1× SMA)
Fenestration-related endoleak and a fractured bridging stent graft	3 (2×celiac trunk and 1× LRA)
Bridging stent graft fracture without clinical consequence	2 (RRA and SMA)
Bridging stent graft stenosis	4 (1× RRA, 1× SMA, and 2× celiac trunk)
Bridging stent graft occlusion	2 (LRA and SMA)
FSG thrombosis	1
Bare stent fracture	1
FSG migration	2
In-folding of a 4-FSG configuration at the aortic level between the SMA and LRA, without endoleak	1
FSG infection	2
Stenosis of external iliac artery	1
Dissection of external iliac artery	1

LRA: left renal artery; SMA: superior mesenteric artery; RRA: right renal artery; FSG: fenestrated stent graft.

Table III.—*Indication for postoperative reintervention.*

Indication	Reintervention (N.=18)
Single complication	
Type 1a endoleak	1
Type 1b endoleak	1
Type 2 endoleak	1
Type 3 endoleak	1
Fenestration-related endoleak (3× LRA)	3
FSG migration	1
FSG infection	1
Stenosis of external iliac artery	1
Dissection of external iliac artery	1
Combination of complications	
Type 1b and 2 endoleak	2
Type 2 and fenestration-related endoleak of celiac trunk and a fractured bridging stent graft	1
Fenestration-related endoleak of LRA and SMA	1
Fenestrated-related endoleak of LRA and a fractured bridging stent graft	1
Fenestrated-related endoleak of celiac trunk and a fractured bridging stent graft and bridging stent graft stenosis of RRA	1
FSG migration with bridging stent graft fracture of RRA and SMA without clinical consequence	1

LRA: left renal artery; SMA: superior mesenteric artery; RRA: right renal artery; FSG: fenestrated stent graft.

Apposition measurements on the first CTA scan could be used as baseline for evaluation of the course of apposition during follow-up. If physicians use a cone-beam CT scan at the end of a FEVAR procedure, this should be performed with contrast. SAL increase could prevent the development of type 1a endoleak during FEVAR follow-up.[4] On the other hand, SAL decrease leading to a type 1a endoleak destabilizes the FSG and leads to increased mortality.[9] This study shows that a >5 mm apposition decrease was mainly due to loss of apposition at the distal sealing zone (and thus without migration of the FSG), which is difficult to recognize on a standard CTA scan. Assessment of SAL on postoperative CTA scan may be beneficial for patient stratification to perform risk-stratified imaging surveillance.[8] Patients with insufficient SAL on the first CTA scan need treatment. Patients with decreasing SAL during follow-up could benefit from more frequent duplex or CTA imaging surveillance in order to investigate the underlying cause of a decreased SAL and to plan an eventual reintervention to prevent or treat a type 1a endoleak.

The costs for the initial treatment of a pAAA and 2 year follow-up are approximately € 40,000 for FEVAR and € 20,000 for open surgical repair.[11, 12] FEVAR is associated with high technical success (97%), low intraoperative visceral artery occlusion (1%), and low 30-day mortality (1%).[13] In contrast, FEVAR is also associated with a higher midterm reintervention rate (odds ratio, 8.32; 95% confidence interval, 3.80-27.16) than open surgical repair.[14] The cost-effectiveness of FEVAR could be improved by reducing reintervention rates. Early reinterventions may be reduced by FSG and bridging stent graft analysis on a cone-beam CTA scan at the end of the FEVAR procedure so that an intraoperative revision can be performed if needed and thus reduce the need for early reinterventions.[15] Furthermore, patient-tailored follow-up, including FSG apposition analysis and geometric analysis of bridging stent grafts on CTA scans, has the potential to predict failures. This should be demonstrated in large prospective trials, in order to determine cut-off values for FSG and bridging stent graft parameters such as SAL.

According to this study and the literature, most complications after FEVAR are fenestration-related.[16] Fenestrations of 3- or 4-FSG configurations show more fenestration-related complications than FEVAR with 1- or 2-FSG configurations (6% *versus* 10%). According to the literature, SMA stenting showed no increased risk of death, major adverse events, type 3 endoleaks, or reintervention, despite technical complexity.[17] Furthermore, catheterization and stenting the celiac trunk is often more challenging due to steep take off, angulation, and early branches. This study shows a median SAL of 28 (25-32) mm and median SAL increase for patients treated with one- or two-FSG configuration. FEVAR with 3- or 4-FSG configuration is an option to treat pAAA in case sufficient apposition length cannot be reached with 1- or 2-FSG configuration. Therefore, preoperative planning remains critical to determine the proximal seal zone. In our planning and sizing, FSGs were 15-20% oversized based on the preoperative aortic neck diameter (according to the advice of the Cook planning team). The range of oversizing is so small, that no statistical analyses was performed if oversizing was correlated to SAL.

Limitations of the study

The study results should be interpreted within the context of the retrospective study design with associated limitations. Second, the study population with only one case of type 1a endoleak was too small to conclude anything about SAL in relation to type 1a endoleak. Third, the inclusion criterion of two CTA scans available potentially introduced a selection bias because patients who died early were not included. Fourth, the results are limited to mid-term follow-up with a large time span of last postoperative CTA scans. Fifth, the study included specifically the Cook Zenith FSG, which is the first-choice device in the UMCG. Results of this study cannot be extrapolated to other types of fenestrated stent grafts. Last, the VIA software is not yet Conformité Européenne-marked or USA Food and Drug Administration-approved. Therefore, clinical implementation and replication of these calculations is not possible. As an alternative to the VIA software, apposition length can be measured over the centerline in a vascular workstation. This would, however, not represent the SAL over the circumference. Validation of SAL showed a repeatability coefficient of 4.1 mm, and an intraclass correlation coefficient with 95% confidence interval of 0.986 (0.968-0.994) mm.[7]

Conclusions

Adequate mid-term apposition of the FSG in the pararenal aorta was achieved post-FEVAR, and the occurrence of type 1a endoleaks was low. The number of reinterventions was, however, substantial and was often related to bridging stent-related complications.

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