Short-term and Mid-term Outcomes after Use of the Native Infrarenal Aorta as Distal Landing Zone for Fenestrated-Branched Endovascular Aortic Repair

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Background: This study aimed to examine outcomes after use of the native infrarenal aorta as distal landing zone for fenestrated-branched endovascular aortic repair (F-BEVAR) of pararenal-thoracoabdominal aortic aneurysms (PRAA-TAAA).
Methods: All F-BEVAR procedures for treatment of PRAA-TAAA (2011–2019) at 2 aortic centers were examined. The outcomes of interest were as follows: i) technical success, ii) perioperative morbidity, iii) preservation of lumbar arteries and the inferior mesenteric artery, iv) type IB endoleaks, v) reinterventions, vi) survival, vii) aneurysm sac behavior, and viii) infrarenal aortic changes.
Results: Twenty consecutive patients with distal landing in the native infrarenal aorta were included (median age 71 years; 25% men). The median number of visible lumbar arteries at baseline was 7, and a patent inferior mesenteric artery (IMA) before the operation was present in 19 (95%) of the cases. There were no deaths within 30 days. One patient (5%), operated on with a 4-BEVAR for a type 2 TAAA, experienced spinal cord ischemia (permanent paraplegia). The median decrease in the number of visible lumbar arteries at the first postoperative scan was 3 from the baseline value, whereas a patent IMA was preserved in 12 out of 19 patients. Only in one case (5%), a type IB endoleak was noted for an overall technical success rate of 95%, which required a standard EVAR 20 months after the initial operation. The median follow-up duration for the study cohort was 491 days; all patients were alive at the longest available individual follow-up, and no instances of new-onset type IB endoleaks were observed. Another 3 late reinterventions (in addition to the one mentioned previously) were performed during midterm follow-up, all because of target vessel instability. In patients with $\geq$12 months of follow-up after the index procedure ($n = 12$, 60% of the entire cohort), no instances of aneurysm sac increase $>$5 mm were noted; the median largest aortic diameter was 51 mm with a median difference from baseline of -6 mm. The median distal landing zone diameter increase was 4 mm from baseline but never beyond the nominal stent-graft diameter, whereas the median aortic bifurcation diameter differed 1 mm from baseline.
Conclusions: This preliminary experience shows that the use of the native infrarenal aorta as a distal landing zone for F-BEVAR is safe in the short term and midterm in patients with suitable anatomy, allowing the sparing of collateral vessels. Longer follow-up is warranted to assess durability.

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INTRODUCTION

The introduction of fenestrated-branched endovascular aortic repair (F-BEVAR) has revolutionized the treatment algorithm of pararenal-thoracoabdominal aortic aneurysms (PRAA-TAAA), mainly owing to the reduced incidence of early morbidity and mortality as compared with open surgical repair.[1] Spinal cord ischemia (SCI) remains a major cause of morbidity and mortality in F-BEVAR because of the loss of direct flow to segmental spinal arteries when an extended segment of the aorta is overstented, with the reported incidence of SCI ranging from 7.8% to 13.6%.[2–5] Thus, whether the native abdominal aorta can be regarded as a durable distal landing zone in selected patients undergoing F-BEVAR, or if the repair should always be extended to the iliac arteries, remains an unanswered question. Distal landing in the infrarenal aorta has the potential benefit of preservation of lumbar arteries, possibly reducing the risk for SCI. In addition, the procedure is simplified, and operative times are often reduced, which may have a positive impact on outcomes. In addition, infrarenal aortic landing could, in some cases, avoid coverage of the inferior mesenteric artery (IMA), which in rare occasions may increase the risk for bowel ischemia. However, manufacturers often recommend the iliac arteries as the distal landing zone with the rationale of a more durable seal. This study aimed to examine short-term and midterm outcomes after use of the native infrarenal aorta as a distal landing zone for F-BEVAR of PRAA-TAAA.

METHODS

Study Design

Between January 1, 2011 and January 31, 2020, 341 consecutive patients suffering from PRAA-TAAA underwent F-BEVAR at 2 vascular centers, of whom 39 had a distal landing in the infrarenal aorta. Nineteen patients with previous open or endovascular repair at the infrarenal aorta were excluded. Thus, a total of 20 patients, who received F-BEVAR with the native infrarenal aorta as the distal landing zone, were included (Fig. 1). The electronic patients' record was retrospectively reviewed for demographics, comorbidities, aneurysm anatomy, details of hospitalization and operation, reinterventions, endoleaks, and survival. Ethical approval was received for this retrospective study.

Operative Procedure

Zenith custom-made stent grafts (Cook Medical LLC, Bloomington, Ind) or off-the-shelf t-Branch was used, and implantation was performed using percutaneous femoral access as first line whenever feasible. In our practice, the native infrarenal aorta is selected as distal landing zone for the F-BEVAR procedure when there are no signs of degeneration and suitable anatomy is present to ensure durability of the repair, including nonectatic diameter (i.e. <30 mm) and adequate length (i.e. >20 mm). Preoperative characteristics of the distal landing zone in the native infrarenal aorta were recorded, including the length of the normal infrarenal aorta that was stented and not stented (and the relative stenting ratio), the diameter of the distal landing zone (and the relative distal device oversizing) and the aortic bifurcation, and the degree of circumferential calcification and cross-sectional thrombus load (both measured using a semiquantitative three-point scale as <25%, 25–50%, or >50%). Generally, 15–20% oversizing of the stent graft compared with the outer-to-outer diameter of the intended distal landing zone was planned, and all landing zones were routinely molded with the compliant Coda balloon (Cook Medical LLC). All operations were performed under general orotracheal anesthesia in a hybrid operating room. Completion aortogram was performed to evaluate exclusion of the aneurysm, patency of the target vessels, and the presence of endoleaks or bleedings.

Follow-up Protocol

All patients had preoperative thin-slice computed tomography angiography (CTA) from the neck to the groin. All CTA images were extracted and analyzed using dedicated software workstations (3mensio Medical Pie, The Netherlands). Postoperatively, an early CTA was arranged before the patient was discharged or within 1 month of the operation. In accordance with institutional protocols, this was followed by a scheduled outpatient visit and imaging at 6 months and annually thereafter. For identification of midterm outcomes (i.e. beyond index hospitalization), follow-up time was calculated for the entire cohort ($n = 20$) as the interval time (in days) between the index procedure and the last available follow-up event (date of last clinical contact, or date of last CTA, or date of intervention, or death).

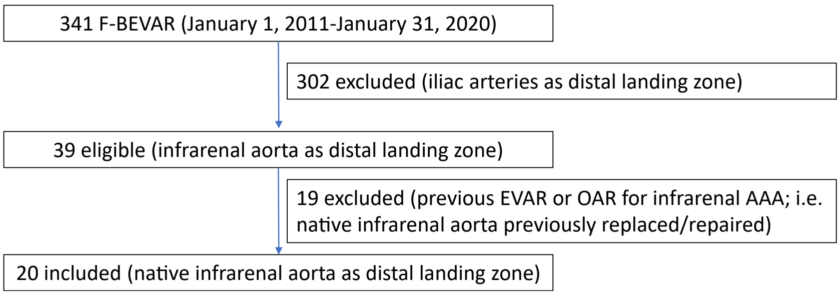

Fig. 1. The flowchart of study cohort selection. F-BEVAR, fenestrated-branched endovascular aortic repair; OAR, open aortic repair; AAA, abdominal aortic aneurysm.

Study End Points

The end points of interest for this study were as follows:

i) technical success (defined as successful deployment of the stent graft by endovascular means only, the absence of type I/III endoleaks on completion angiography, and patent target vessels);
ii) perioperative morbidity (defined as major adverse events [MAE] as per Society for Vascular Surgery reporting standards[6]: cumulative end point of any-cause mortality, myocardial infarction, new-onset congestive heart failure, blood loss >1L, acute kidney injury, stroke, SCI, or bowel ischemia);
iii) number of IMA/visible lumbar arteries preserved;
iv) type IB endoleaks (defined as early if evident at completion aortogram or within the first postprocedural CTA or otherwise as new-onset);
v) reinterventions;
vi) survival (defined as the time between surgery and final follow-up, or death from any cause);
vii) treated aneurysm sac behavior. This was classified on a three-point scale as decreased, stable, or increased based on absolute increase or decrease ≥5 mm in the maximal transverse diameter on centerline measurements as compared with preoperative CTA;
viii) infrarenal aortic changes (at the level of the distal landing zone and aortic bifurcation).

Statistical Analysis

Continuous variables were reported as median and interquartile range. Categorical variables were reported as count and percentage. We calculated 95% confidence intervals for the median difference (in mm) between diameter of distal landing zone and nominal diameter of the stent graft. Microsoft Excel 2018 was used for statistical analysis.

RESULTS

Study Population and Anatomic Characteristics

The median age of the 20 patients included was 71 years; 5 patients (25%) were men (Table I). Ten patients (50%) had undergone previous aortic repair (at a level different than the infrarenal aorta, including 9 cases of first stage thoracic endovascular aortic repair (TEVAR) before the planned F-BEVAR procedure). Sixteen patients (80%) had American Society of Anesthesiology class ≥3. Although most repairs were performed in patients with degenerative aneurysms (n = 17, 85%), 2 patients (10%) were treated for mycotic saccular aneurysms, and 1 patient (5%) received repair for a postdissection aneurysm. Fourteen patients (70%) were treated for TAAA (11 Crawford extent I—III, 3 Crawford extent IV), whereas the remaining 7 (30%) had PRAA. The median distal landing zone diameter was 22 mm, and the median infrarenal aorta length was 102 mm (Table II). The median number of visible lumbar arteries at preoperative CTA was 7, whereas a patent IMA before the operation was present in 19 (95%) of the cases.

Operative Details

The procedure was performed electively in 18 cases (90%), whereas the remaining were carried out in an acute setting for symptomatic ($n = 1$) or ruptured ($n = 1$) aneurysms in 2 patients for whom a custom-made device was already available. In 14 procedures (70%), ≥4 target vessels were incorporated into the repair (Table III). A custom-made device was used in 19 cases (95%), with 1 off-the-shelf device implanted in the remaining patient. The median

Table I. Demographics, comorbidities, and preoperative work-up

Variables	Total = 20 *N* (%) or median (IQR)
Demographics	
Age (years)	71 (69–74)
Age ≥80 (years)	2 (10%)
Males	5 (25%)
BMI (kg/m^2)	27 (25, 30)
Obesity (BMI ≥30)	8 (40%)
Comorbidities	
Ischemic heart disease	5 (25%)
Congestive heart failure	2 (10%)
Atrial fibrillation	4 (20%)
Hypertension	17 (85%)
Dyslipidemia	16 (80%)
Smoking	
Never	4 (20%)
Prior	10 (50%)
Current	5 (25%)
Chronic obstructive pulmonary disease	7 (35%)
Diabetes mellitus	1 (5%)
Chronic kidney disease stage III–V	6 (30%)
Dialysis	0%
History of stroke	2 (10%)
Any prior aortic repair	10 (50%)
1st stage TEVAR	9 (45%)
Ascending replacement	4 (20%)
Frozen elephant trunk	1 (5%)
Preoperative work-up	
ASA class ≥3	16 (80%)
Preoperative hemoglobin (g/dL)	13.5 (12.5, 14.5)
Preoperative anemia	4 (20%)
Preoperative eGFR (ml/min/1,73 m^2)	68 (57, 75)
Antiplatelets	16 (80%)
Anticoagulants	5 (25%)
Statin	17 (85%)
Diuretics	4 (20%)
ACEi/ARB	14 (70%)
CCB/BB	15 (75%)

BMI, body mass index; ASA, American Society for Anesthesiology; eGFR, estimated glomerular filtration rate; ACEi, angiotensin converting enzyme inhibitors; ARB, angiotensin receptor blockers; CCB, calcium channel blockers; BB, beta blockers; IQR, interquartile range.

distal device diameter and distal device oversizing were 27 mm and 23%, respectively. Operative time, fluoroscopy time, and contrast volume median values were 260 minutes, 82 minutes, and 135 mL, respectively. The median number of visible lumbar arteries at the first postoperative CTA was 4 with a median decrease of 3 from the baseline value.

Table II. Anatomic characteristics

Variables	Total = 20 *N* (%) or median (IQR)
Etiology	
Mycotic	2 (10%)
Degenerative	17 (85%)
Postdissection	1 (5%)
Largest aortic diameter (mm)	60 (55, 65)
Distal landing zone diameter (mm)	22 (20, 23)
Aortic bifurcation diameter (mm)	19 (17, 22)
Aneurysm extent	
Pararenal/suprarenal	6 (30%)
Thoracoabdominal	14 (70%)
Infrarenal aorta length (mm)	102 (90, 108)
Infrarenal aorta calcification	
<25%	13 (65%)
25–50%	6 (30%)
>50%	1 (5%)
Infrarenal aorta thrombus	
<25%	17 (85%)
25–50%	3 (15%)
>50%	0%
Number of visible lumbar arteries	7 (6, 8)
Patent inferior mesenteric artery	19 (95%)

IQR, interquartile range.

The IMA was effectively preserved in 12 out of 19 patients with a patent IMA preoperatively.

Short-term Outcomes

The overall rate of perioperative MAE was 40%, with 8 patients experiencing at least 1 adverse event within 30 days of the index repair (Table IV). None of the patients died within 30 days. Five patients (25% of the study cohort) developed acute kidney injury in the immediate postoperative period; 2 out of 5, who required temporary dialysis during index hospitalization, developed renal function deterioration over time (defined as estimated glomerular filtration rate reduction >20% from baseline value), but none required new-onset permanent dialysis. One patient (5% of the cohort) experienced SCI (permanent paraplegia) during the immediate postprocedure phase. This patient suffered from a 90 mm Crawford extent I TAAA that was repaired in a staged fashion (first stage: carotid-subclavian bypass with zone 2 TEVAR; second stage: custom-made F-BEVAR). The median length of the stented and nonstented infrarenal aorta was 49 mm and 51 mm, respectively, with a median infrarenal stenting ratio of 50%. Six unplanned reinterventions were required in the immediate postoperative period, including 3 cases of

Table III. Operative details

Variables	Total = 20 *N* (%) or median (IQR)
Elective repair	18 (90%)
Staged repair	10 (50%)
Prophylactic lumbar spinal drains	11 (55%)
Device type	
Custom-made	19 (95%)
Off-the-shelf	1 (5%)
Physician-modified	0%
Device design	
Only fenestrations	8 (40%)
Only branches	5 (25%)
Both fenestrations and branches	7 (35%)
Number of target vessels involved	
<4	6 (30%)
≥4	14 (70%)
Proximal landing zone	
Proximal thoracic	10 (50%)
Mid thoracic	1 (5%)
Distal thoracic	9 (45%)
Left subclavian artery management	
Not covered	14 (70%)
Covered, revascularized	6 (30%)
Distal device diameter (mm)	27 (24, 30)
Distal device oversizing (%)	23 (18, 26)
Bilateral percutaneous femoral access	16 (80%)
Upper arm access	6 (30%)
Intraoperative transfusion	8 (40%)
Operative time (minutes)	260 (180, 300)
Fluoroscopy time (minutes)	82 (69, 102)
Contrast volume (mL)	135 (118, 198)
Postprocedural hospital LoS (days)	8 (5, 10)
Intensive care unit LoS (nights)	2 (1, 3)

LoS, length of stay; IQR, interquartile range.

Table IV. Short-term outcomes

Variables	Total = 20 *N* (%) or median (IQR)
30-day MAE	8 (40%)
Acute kidney injury[a]	5 (25%)
Respiratory failure[b]	4 (20%)
Estimated blood loss >1L	2 (10%)
New-onset congestive heart failure	1 (5%)
Spinal cord ischemia	1 (5%)
Myocardial infarction	0%
Stroke	0%
Bowel ischemia	0%
Mortality	0%
Early unplanned reinterventions	6 (30%)
Length of the stented infrarenal aorta (mm)	49 (38, 66)
Length of the nonstented infrarenal aorta (mm)	51 (28, 54)
Stenting ratio of the infrarenal aorta (%)	50 (42, 69)
Visible lumbar arteries	4 (2, 5)
Difference from baseline	−3 (−2, −4)
Inferior mesenteric artery preserved[c]	12 (63%)
Early type IB endoleaks	1 (5%)
Technical success	19 (95%)

MAE, major adverse events; IQR, interquartile range.
[a]Defined as increase in creatinine value >2-fold from baseline and/or decrease in eGFR >50% from baseline.
[b]Defined as prolonged need for invasive mechanical ventilation (>48 hours) or unplanned reintubation.
[c]The proportion of the preserved inferior mesenteric artery (IMA) was calculated as the number of IMA visible at the immediate postoperative CTA ($n = 12$) divided by the total number of IMA patent at baseline ($n = 19$).

groin exploration for access-site complications and 3 cases of kidney bleeding that required embolization. In one case (5%), a type IB endoleak was noted at completion angiogram for an overall technical success rate of 95%. In this specific patient, a type II TAAA repair was performed in one-stage fashion because of a large aneurysm (maximal transverse diameter 70 mm). A custom-made three-branched stent graft was used with proximal TEVAR extension to achieve a secure landing zone. The abdominal aortic landing zone was 16 mm in diameter with mild calcification and no thrombus. The distal stent-graft diameter was 22 mm, thereby resulting in 37% oversizing. The type IB endoleak was corrected with insertion of a Palmaz stent to improve the wall apposition of the stent graft, and the maneuver resulted in the leak being no longer visible. However, the patient developed a subsequent recurrent leak that required EVAR 20 months after the initial F-BEVAR operation. A Gore Excluder abdominal stent graft was used at this time.

Midterm Outcomes

The median follow-up duration for the study cohort was 491 days; all patients were alive at the longest available individual follow-up, and no instances of new-onset type IB endoleaks were observed (Table V). Another 3 late reinterventions (in addition to the one mentioned previously) were performed during midterm follow-up, all because of target vessel instability (2 renal stents, 1 superior mesenteric stent). In patients with ≥12 months of follow-up after the index procedure ($n = 12$, 60% of the entire cohort), no instances of aneurysm sac increase >5 mm were noted; the median largest aortic diameter was 51 mm with a median difference from baseline of −6 mm. The median distal landing zone diameter increase was 4 mm from baseline but never beyond the nominal stent-graft diameter,

Table V. Midterm outcomes

Variables	Total = 20 *N* (%) or median (IQR)
Median follow-up duration: 491 days (IQR 381−772)	
Survival	100%
New-onset type IB endoleaks	0%
Late reinterventions	4 (20%)
Reinterventions for type IB endoleaks	1 (5%)
Largest aortic diameter (mm)	51 (41, 61)
Difference from baseline	−6 (−1, −11)
Aneurysm sac behavior	
Decreased	8 (66, 5%)
Stable	4 (33, 5%)
Increased	0%
Distal landing zone diameter (mm)	26 (23, 27)
Difference from baseline	4 (3, 5)
Aortic bifurcation diameter (mm)	22 (18, 23)
Difference from baseline	1 (0, 3)

For identification of midterm outcomes (i.e. beyond index hospitalization), follow-up time was calculated for the entire cohort (n = 20) as the interval time (in days) between the index procedure and the last available follow-up event (date of last clinical contact, or date of last CTA, or date of intervention, or death).
IQR, interquartile range.

whereas the median aortic bifurcation diameter differed 1 mm from baseline.

DISCUSSION

The main findings from our study are that, in patients with suitable anatomy, use of the native infrarenal aorta as distal landing zone for F-BEVAR is safe and feasible with satisfactory results at midterm. A large part of the native abdominal aorta can be left unstented, resulting in preservation of lumbar arteries and/or IMA in a significant number of cases (Figs. 2 and 3). Indeed, the main reason for having distal landing at the infrarenal level is to decrease the overall length of aortic coverage, thereby preserving collateral vessels; it is reasonable to assume that this may in turn contribute to reducing the risk of spinal or mesenteric ischemia. However, as one patient in this series experienced permanent paraplegia, it is important to underline that preservation of distal lumbar arteries may reduce the risk of SCI but does not remove it, given its multifactorial origin.

Use of tubular stent grafts for endovascular treatment of infrarenal aneurysms has been previously reported, but strongly criticized because of high incidence of migration and type I endoleaks.[7,8] Consequently, most vascular specialists abandoned this option and manufacturers stopped development of tubular endografts. However, with the recent advent of custom-made technology, this approach has gained renewed interest for treatment of focal infrarenal aortic pathologies with suitable morphology.[9,10] In our series, infrarenal aortic degeneration and type IB endoleaks were not frequent during midterm follow-up (all but one the late reinterventions recorded were due to stenosis/occlusion of the target renal-mesenteric vessels, whereas in all cases with >12 months of follow-up, the aneurysm sac was reduced or stable in size); this approach does not seem to compromise the durability and effectiveness of the repair. To that note, long-term results of infrarenal native aorta fixation of F-BEVAR are missing, with only one recent publication from Law et al. that specifically focused on this topic in a series of 40 patients.[11] Indeed, previous studies on outcomes of F-BEVAR have not specifically reported the characteristics of the distal landing zone, although they usually reported incidence of type IB endoleaks in the range of 0−1,4%.[12] Although most of these endoleaks seemed to origin from iliac arteries, the absence of specific information regarding their exact source makes any cross-series comparison unreliable. Therefore, our study provides additional evidence regarding the short-term feasibility and safety, as well as midterm effectiveness and durability of the infrarenal landing technique for F-BEVAR, which might become the preferential approach for anatomically suitable cases (i.e., when the native aorta presents adequate morphology at the infrarenal level to be used as distal landing zone) provided further research will confirm these preliminary findings.

In the study from Law et al.[11] where the authors investigated the safety and durability of native abdominal aorta in 40 patients undergoing F-BEVAR, no immediate or delayed type IB endoleaks were noted, and distal sealing was intact during follow-up, although dilatation in the sealing zone was noted. Similar findings were recorded in the present analysis despite the smaller sample size; a gradual enlargement of the infrarenal aorta at the stent-graft landing zone could be noted, whereas the aortic bifurcation remained stable. However, growth up to 2 years could be attributed to the distal landing zone assuming the nominal diameter of the endograft (Fig. 4). The degeneration process was likely accelerated by continual radial stress of the self-expanding stent-graft like iliac degeneration, when the stent graft is landed distally at the iliac artery level.[13,14]

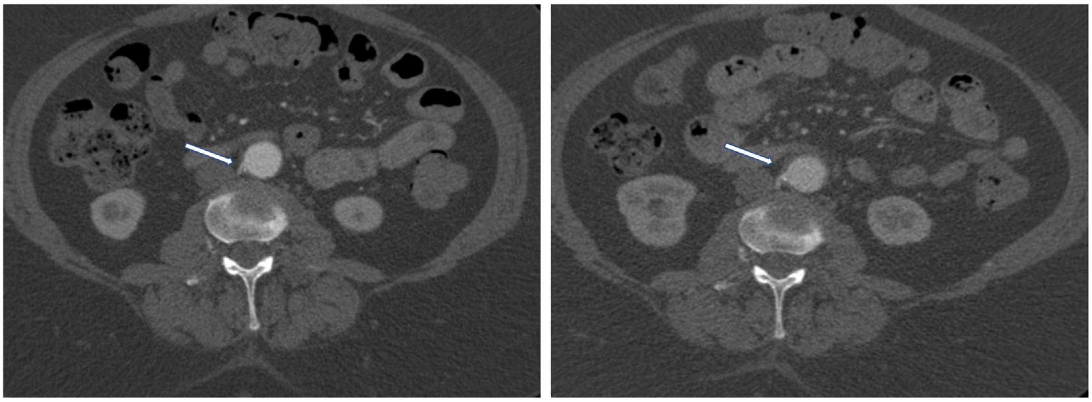

Fig. 2. Left box: axial scan from preoperative computed tomography angiography (CTA) shows the presence of a patent right lumbar artery in a patient planned for fenestrated-branched endovascular aortic repair with distal landing in the native infrarenal aorta. Right box: axial scan from CTA at 30 days in the same. The examination shows preservation of the patent right lumbar artery (arrow) below the distal stent-graft landing zone.

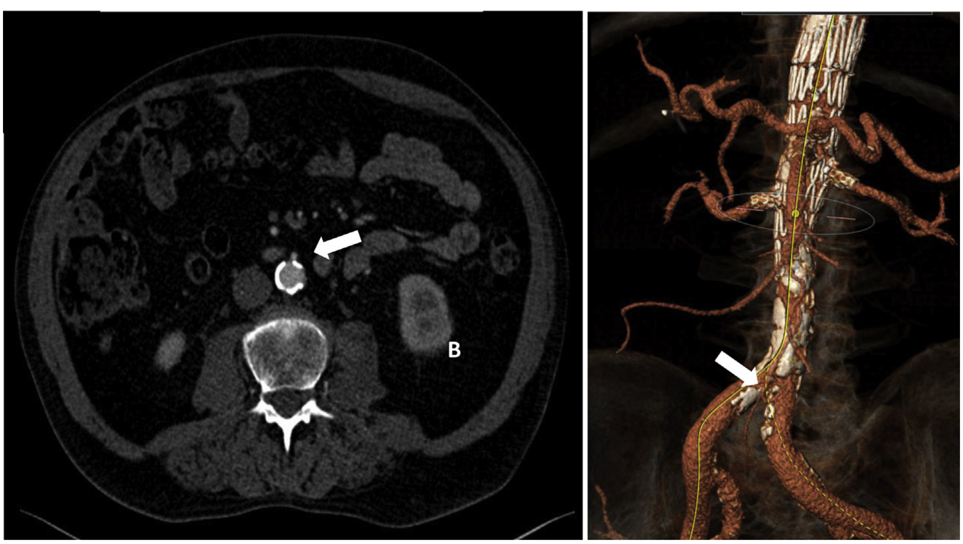

Fig. 3. Left box: axial scan from preoperative computed tomography angiography (CTA) shows the presence of a patent inferior mesenteric artery (IMA) in a patient planned for fenestrated-branched endovascular aortic repair with distal landing in the native infrarenal aorta. Right box: CTA at one-year follow-up in the same patient with three-dimensional volume reconstruction. The examination shows preservation of the patent IMA (arrow), good position of the endograft with patent renal-mesenteric target vessels, and absence of infrarenal aortic degeneration.

Occurrence of SCI remains a devastating event after F-BEVAR and is strongly and independently associated with worse short-term and long-term survival.[15,16] The risk of SCI seems to exist on a continuum, increasing as aortic coverage increases,[17] and given the presence of an extensive longitudinally continuous collateral spinal network, the number and/or percentage of segmental arteries covered, rather than the loss of any specific one, might be a more useful indicator of the risk for postoperative paraplegia than the length of aortic coverage alone.[18–20] In that sense, preservation of collateral vessels might bear the potential to translate into clinical significance for reduction of postoperative neurological complications. However, SCI after F-BEVAR is a complex and multifactorial

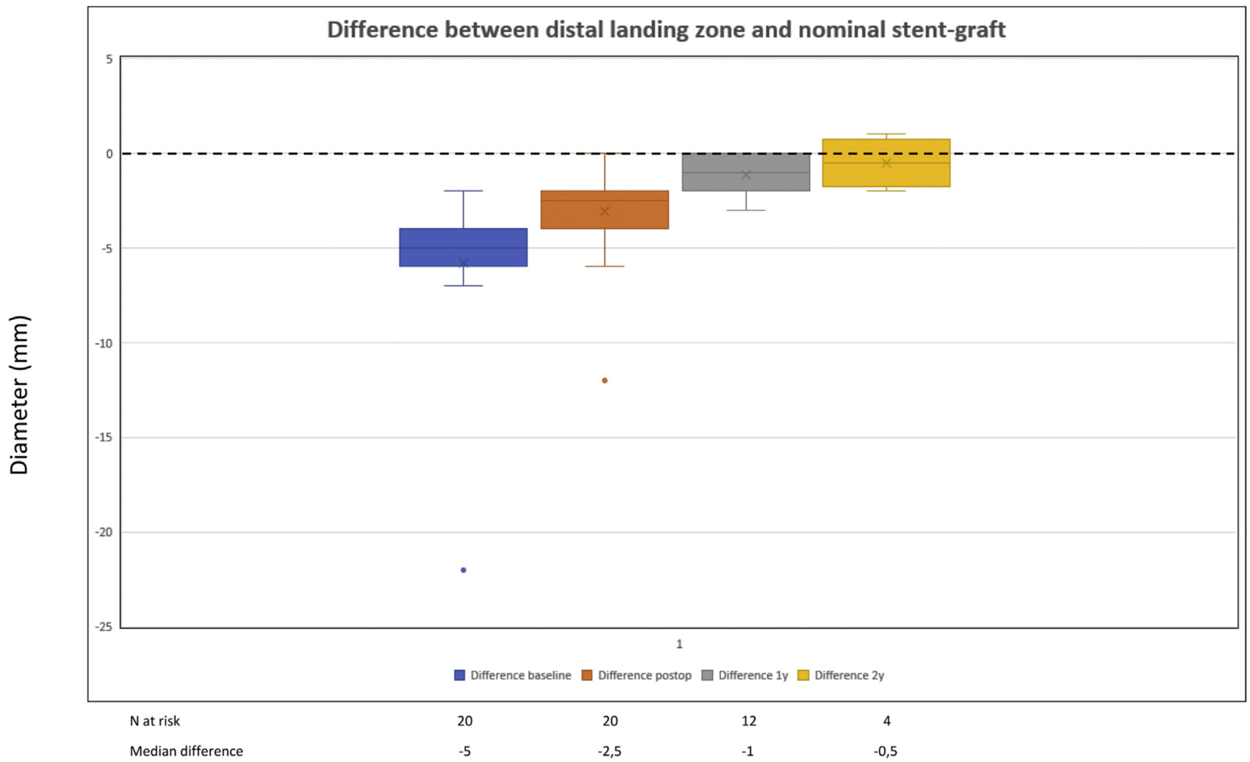

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Fig. 4. Changes over time in the difference between distal landing zone diameter and nominal stent-graft diameter. The dashed line indicates the distal landing zone diameter reaching the nominal stent-graft diameter. The error bars indicate the 95% confidence interval.

entity, and its prevention relies on multimodal protection strategies, including staging of repair, prophylactic lumbar spinal drains, early restoration of pelvic flow, and hemodynamic optimization.[21,22] In that sense, a careful balance is to be sought between the need to preserve as much collateral flow as possible and the requirement for a durable repair. In the only case of type IB endoleak recorded in this series, infrarenal landing was chosen because extensive repair was carried out in nonstaged fashion (owing to the presence of a large aneurysm). Nevertheless, despite the extensive repair, the patient did not develop any neurologic complications and the endoleak was successfully treated with a standard EVAR 20 months later.

As demonstrated in this series, the technique of F-BEVAR with distal landing in the native infrarenal aorta is easily feasible for PRAA-TAAA, provided a healthy segment of the infrarenal aorta is present for landing. Design of the stent graft is not typically a problem in custom-made devices, as the distal diameter of the fenestrated-branched main body can be individually sized to seal at the distal landing site. However, as noted by Law et al.,[11] for the T-branch device or surgeon-modified endografts, a distal tubular stent graft of a larger diameter could be necessary to fit in the infrarenal aorta which in turn might lead to excessive oversizing and undermine stent-graft apposition to the aortic wall resulting in a type IB endoleak. Although size discrepancy might be corrected by adding more radial force with a giant Palmaz stent (Cordis Inc),[23,24] this option does not preclude further relapse of type IB endoleaks. However, in concordance with the study of Law et al.,[11] we were similarly able to demonstrate that type IB endoleaks are rare instances with this approach provided a healthy segment of the infrarenal aorta is chosen as distal landing site. Clearly, extended follow-up and experience are warranted to confirm these preliminary findings and ensure that the distal seal is not compromised over time.

Another important technical point during planning was the need to prepare for future distal extension. Preferably, a distal stent-graft segment of ≥40 mm below the most distal fenestration or branch should be planned for F-BEVAR with distal landing in the infrarenal aorta, to allow for safe docking of future EVAR devices. This is an important aspect and, if meticulously planned, the technique of distal landing in the native abdominal aorta does not compromise future infrarenal repair options when needed. These might be achieved with conventional EVAR devices or custom-made solutions featuring an inverted iliac limb in cases where the distance from the lowest incorporated renal artery to the aortic bifurcation is shorter than the main body of standard aortic stent grafts.[25]

Study Limitations

One shortcoming of this study was the lack of a comparison group, without which it was unfeasible to answer the question whether infrarenal landing is better, equal, or worse than iliac landing in F-BEVAR cases suitable for both solutions. Indeed, although the treated aortas in this series could have been treated with standard bifurcated configurations, we elected to implement the distal infrarenal landing technique whenever anatomically suitable to reduce overall aortic coverage, preserve collateral vessels, and simplify the procedure. Therefore, definition of a comparative study group was challenging, as in our practice infrarenal landing is only used selectively in anatomically feasible cases with nonaneurysmal infrarenal aortas. Using F-BEVAR with iliac landing as comparison group would have been inappropriate, as in our practice all patients receiving distal landing at the iliac level had infrarenal aortic enlargement and thus were deemed unsuitable candidates for the described approach. The retrospective nature of study design and small sample size might also risk inadequate or incomplete report of outcomes. Further follow-up of larger cohorts is required to definitively answer questions regarding long-term effectiveness and durability.

CONCLUSIONS

This preliminary experience shows that the use of the native infrarenal aorta as a distal landing zone for F-BEVAR is safe in the short term and midterm in patients with suitable anatomy, allowing the sparing of collateral vessels. Longer follow-up is warranted to assess durability.

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