Nonfenestrated Options for Treating Compromised AAA Necks

How to overcome juxtarenal AAAs.

BY CORNELIS G. VOS, MD, PHD; RICHTE C.L. SCHUURMANN, MSC; AND JEAN-PAUL P.M. DE VRIES, MD, PHD

Endovascular treatment of abdominal aortic aneurysms (AAAs) is the preferred treatment in most centers worldwide. However, standard endovascular aneurysm repair (EVAR) is unsuitable in approximately 40% to 50% of AAA cases, most frequently due to a compromised neck.[1] The neck can be compromised by various well-known factors, including short length, large diameter, large supra- and infrarenal angulation, thrombus load, and calcification.[2] As an alternative to angulation, aortic curvature has been identified as a better predictor of intraoperative and late (> 1 year) type Ia endoleak.[3,4] Angulation measurements may result in triangular oversimplification of the aortic anatomy, whereas curvature includes the true course of the juxtarenal anatomy and three-dimensional tortuosity over the entire relevant aortic trajectory.

Nowadays, open repair is not the only alternative to standard EVAR, and new techniques and improvements of endografts and stent grafts have emerged that enable seal in the juxta- and pararenal aorta, including fenestrated (FEVAR) or branched endografts. Major drawbacks of FEVAR are its costs, the fact that it is not an off-the-shelf solution (manufacturing time is 6–8 weeks), and the procedure is more demanding and leads to increased operating and fluoroscopy time and radiation dose.[5]

Alternatively, chimney or parallel grafts can be used in combination with EVAR (ChEVAR) or endovascular aneurysm sealing (ChEVAS).[6,7] Heli-FX EndoAnchors (Medtronic) can also be used to improve fixation and seal.[8] For some patients, an open or hybrid repair is the most appropriate solution. This article discusses nonfenestrated options for the treatment of AAAs with compromised necks.

ChEVAR

The main goals of the chimney technique are to create adequate proximal sealing in the juxta- or pararenal aorta with proximal extension of the endograft while maintaining perfusion of branch vessels using covered stents (ie, chimneys). Advantages of the technique over FEVAR are the off-the-shelf availability and less complex nature of the procedure. Anatomic features favoring ChEVAR over FEVAR are hostile (narrow, tortuous, or stenosed) iliofemoral access, downward angulated renal arteries, ostial stenosis of target vessels, angulated visceral aortic segment, and previous (endovascular) aortic repair, resulting in a short distance between the new proximal seal line and the flow divider or bifurcation of previous aortic reconstruction.[9,10]

Drawbacks of ChEVAR include the risk of type Ia endoleak due to gutter formation between the endograft and chimney grafts, anatomic limitations such as upper extremity artery occlusion or aortic arch occlusions or anomalies, and shaggy thoracic aorta with risk of thromboembolic complications.[10] The aortic neck

diameter should not be < 20 mm or > 30 mm. Finally, brachial access and manipulation through the aortic arch carries a stroke risk of up to 5%, whereas this is < 1% for FEVAR.[11]

Two recent meta-analyses compared the outcomes of ChEVAR and FEVAR in juxtarenal AAAs.[5,12] Li et al evaluated 15 studies published until 2013 that included 158 ChEVAR and 542 FEVAR patients.[5] Mortality was significantly higher for ChEVAR, with a pooled 30-day mortality rate of 3.8% versus 1.1% (P = .02) and a mortality rate of 8.5% during 14-month follow-up versus 5.4% during 12-month follow-up (P = .01) for ChEVAR and FEVAR, respectively. Lower operative and fluoroscopy time, contrast use, and blood loss were reported for ChEVAR.[5] A meta-analysis by Yaoguo et al evaluated 42 studies comparing ChEVAR and FEVAR that were published until 2015 and included a total of 2,264 patients.[12] For ChEVAR and FEVAR, respectively, the 30-day mortality rate was 2.4% versus 3.2% (P = .46), the aneurysm-related mortality rate was 3.2% versus 1.4% (P = .02), and the target vessel stenosis or occlusion rate was 3.4% versus 3.6%. (P = .79). Type I endoleak occurred in 3.4% versus 2% (P = .09), and type II endoleak occurred in 5.3% versus 5.4% (P = .91), respectively. Reinterventions were much more common in the FEVAR group (11.7% vs 5.6% in ChEVAR patients; P = .001).[12] Important limitations of these meta-analyses include that the studied groups are not comparable because some of the ChEVAR cohorts included acute and semiacute cases, anatomic criteria were often not well described, and there was considerable heterogeneity in techniques and devices used. Moreover, the included studies have a high risk of selection bias.

The PERICLES registry represents the largest collected worldwide multicenter experience with ChEVAR and was not included in the previously described meta-analyses.[13] The study included 898 chimney grafts in 517 patients, and the mean follow-up was 17.1 months. A 30-day mortality rate of 4.9% was reported (3.7% when ruptured AAAs were excluded). Technical success was 97.1%, with 2.9% persistent type Ia endoleak at the end of the procedure, although only two cases (0.4%) of type Ia endoleak persisted at the first follow-up CT. There were three late-onset type Ia endoleaks due to gutter formation that could be treated by endovascular means.[13]

In another report, in an attempt to standardize the ChEVAR technique, the authors described the results of a prospective cohort of 128 patients (187 chimney grafts) using the Endurant stent graft (Medtronic) combined with the balloon-expandable Advanta V12 covered stent (Getinge) in all cases.[14] Results included 100% technical success, 30-day mortality rate of 0.8%, midterm mortality rate of 17.2% (mean follow-up, 24.6 months), type Ia endoleak rate at follow-up of 1.6%, and 93.1% freedom from chimney graft–related reinterventions.[14]

ChEVAR is a valuable technique that should be available in the armamentarium of physicians treating juxtarenal AAAs. Although the exact role of ChEVAR and FEVAR remains a topic of debate, ChEVAR is safe and effective and might be preferred over FEVAR depending the clinical and anatomic characteristics of individual patients.

ChEVAS

ChEVAS is a chimney technique incorporating EVAS using the Nellix device (Endologix). By improving the sealing around the chimney grafts, ChEVAS might be able to mitigate the risk of gutter endoleak between chimney grafts and aortic endografts.[7] The largest experience to date was a retrospective multicenter cohort of 154 patients treated with ChEVAS for unruptured juxtarenal and pararenal AAAs reported by Thompson et al.[15] The 30-day mortality and aneurysm-related mortality rates at 1 year were 2.8% and 5.7%, respectively. One type Ia (0.6%) and two type Ib (1.3%) endoleaks occurred within 90 days, and there were no type II or III endoleaks. Freedom from type Ia endoleaks and all endoleaks at 1 year was 95.7% and 94.2%, respectively. Reinterventions after 1 year were performed in 10.8% of patients. Target vessel patency at 1 year was 97.7%, 99.3%, 100%, and 100% for the left renal, right renal, superior mesenteric, and celiac arteries, respectively.[15] However, mid- and long-term follow-up studies are currently lacking, and it is unknown whether the juxtarenal seal is sustainable.

HELI-FX ENDOANCHORS

Heli-FX EndoAnchors are small helical screws that lock the endograft to the aortic wall to obtain strong transmural fixation. Cadaver studies with human aortas demonstrated that Heli-FX EndoAnchors enhance endograft fixation with the strength of an open surgical vascular anastomosis.[16]

The prospective ANCHOR trial included over 300 patients, and results from 1-year follow-up for the first 100 patients have been published.[17] The cohort was divided into a group of primary cases (n = 73) and a group of revision cases (n = 23) in which the Heli-FX EndoAnchors were placed in a procedure separate from the initial EVAR procedure. Despite the fact that a hostile neck was present in 83% of patients, freedom from type Ia endoleak at 1 year was 95% in the primary

group and 77% in the revision group (P = .006).[17] There were no open conversions, aneurysm-related deaths, or ruptures during follow-up.[8,17]

These results indicate that Heli-FX EndoAnchors can be an effective adjunct to standard EVAR to prevent proximal neck complications such as migration and loss of seal. They can also be used to treat type Ia endoleaks. EndoAnchors can particularly be beneficial in patients with short, wide, conical, or severely angulated necks.[8] EndoAnchors can be used to increase apposition to the outer curve when the endograft tends to follow the inner curve, leading to inadequate sealing. Additionally, it might be reasonable to consider prophylactic placement of EndoAnchors in patients with many comorbidities to reduce the risk for reinterventions, those at a high risk of becoming lost to follow-up, or in patients with a long life expectancy. Initial studies demonstrated that Heli-FX EndoAnchors can also be used to decrease gutter volume after ChEVAR, although more data are needed to demonstrate safety and effectiveness.[18,19] A recent study reported that EndoAnchors might have a protective effect on aortic neck dilatation.[20] This finding might have important implications on the durability of EVAR, especially in patients with compromised necks. However, long-term data are needed to confirm these findings.

Rarely reported complications of Heli-FX EndoAnchors include maldeployment leading to free-floating anchors, fracture of the EndoAnchor during placement, and "toffee wrapper" sheath twisting during manipulations in tortuous aortoiliac anatomy.[8]

OPEN OR HYBRID REPAIR

Before the rise of EVAR, open repair was the gold standard for treating AAAs, and even after the development of EVAR, it remained the treatment of choice for juxtarenal AAAs for several years. There still is a place for open repair in the treatment of AAAs. Anatomic parameters can preclude endovascular repair, such as small-caliber orifices of visceral arteries, severe juxtarenal aortic angulation, hostile (eg, occluded, tortuous, small-caliber) access vessels, absence of an adequate sealing zone, previous aortic reconstructions, or anatomic variations including horseshoe kidney with aberrant renal arteries. In addition, open repair might be preferred in young, fit patients with a low operative risk and a long life expectancy.

Recently, van Lammeren et al demonstrated an acceptable 30-day mortality rate of 3.4% in a contemporary cohort of 214 patients with juxtarenal AAAs treated by elective open repair.[21] The main drawbacks compared to endovascular alternatives are illustrated in a recent analysis by Gupta et al.[22] In a cohort identified from the National Surgical Quality Improvement Program database comparing FEVAR (n = 535) to open repair (n = 1,207), there was an increased risk for 30-day mortality (odds ratio [OR], 2.6; 95% confidence interval [CI], 1.3–5), pulmonary complications (OR, 8.8; 95% CI, 5.1–15), cardiac complications (OR, 3.4; 95% CI, 1.8–6.6), renal failure necessitating dialysis (OR, 3.8; 95% CI, 1.9–7.7), and return to the operating room (OR, 2.5; 95% CI, 1.6–4.0).[22]

Finally, a hybrid approach typically includes debranching of target vessels through an open surgical procedure, followed by endovascular exclusion of the pararenal aneurysm. In some cases, a hybrid approach can be considered to reduce the extent of the surgical procedure or avoid exposure of the infrarenal or paravisceral aorta. Additionally, a hybrid approach does not require aortic clamping and allows revascularization of individual visceral arteries consecutively instead of causing overall ischemia until finalizing the proximal anastomosis during aortic cross-clamping or reimplantation of visceral vessels. However, a major drawback of hybrid repair is that it exposes the patient to both the invasiveness of open repair and durability issues of EVAR. Despite these drawbacks and the preference for an endovascular-first strategy, there is still room for open and hybrid repair in individual cases.

SUMMARY

Several nonfenestrated options are available for the treatment of AAAs with a compromised neck. The off-the-shelf availability and the advantages of ChEVAR and/or ChEVAS justify their role in the treatment of AAAs with compromised necks, especially in (semi) acute cases. Furthermore, Heli-FX EndoAnchors can be a valuable adjunct when treating short, wide, conical, or highly angulated necks to maintain or improve apposition and prevent migration. Open or hybrid repair is still required for patients who are unsuitable for EVAR or in young and uncompromised patients with a long life expectancy who do not want to undergo yearly follow-up with the risk of necessary reintervention. ■

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Cornelis G. Vos, MD, PhD
Department of Surgery
Onze Lieve Vrouwe Gasthuis
Amsterdam, The Netherlands
Disclosures: None.

Richte C.L. Schuurmann, MSc
Department of Vascular Surgery
St. Antonius Hospital
Nieuwegein, The Netherlands
Technical Medicine, Faculty of Science and Technology
University of Twente
Enschede, The Netherlands
Disclosures: None.

Jean-Paul P.M. de Vries, MD, PhD
Department of Vascular Surgery
St. Antonius Hospital
Nieuwegein, The Netherlands
j.vries@antoniusziekenhuis.nl
Disclosures: None.