Percutaneous Endovascular Repair of Abdominal Aortic Aneurysm with Coexisting Horseshoe Kidney: Technical Aspects and Review of the Literature

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ABSTRACT

Surgical repair of abdominal aortic aneurysms (AAAs) with coexisting horseshoe kidney (HSK) is technically challenging because of complex anatomy. Endovascular repair has emerged as a common approach to AAA repair and represents a valid alternative in selected patients with AAA and concomitant congenital renal anomalies. We report a case of successful percutaneous endovascular repair in a patient with coexistent AAA and HSK. Careful preoperative planning is essential in successful endovascular management of abdominal aneurysms in these patients.

KEYWORDS: Abdominal aortic aneurysm, horseshoe kidney, congenital renal anomaly, endovascular abdominal aortic aneurysm repair

Abdominal aortic aneurysm (AAA) repair with coexisting horseshoe kidney (HSK) has been periodically reported in the surgical literature ever since Phelan et al published the first successful repair in 1957.¹ The complicated anatomy of HSK, its intimacy to the aorta, and the variability of its vascular and collecting systems make open AAA repair challenging. Endovascular aneurysm repair (EVAR) has emerged as a common approach to treat AAA.² It has become a valid alternative in selected patients with AAA and concomitant congenital renal anomalies.³ We report the case of a 67-year-old patient with HSK who underwent EVAR, discuss the technical vagaries of perioperative planning and graft deployment, and review the literature on endovascular management of AAA associated with congenital renal anomalies.

CASE HISTORY

A 67-year-old man was referred to our center with an asymptomatic AAA. His medical history was significant for hypertension, hyperlipidemia, peripheral arterial disease, and chronic renal insufficiency with a baseline creatinine level of 1.7 mg/dL. Abdominal and pelvic computed tomography angiography (CTA) with multiplanar and three-dimensional reconstruction (3D-CTA) (Preview, M2S, Lebanon, NH) revealed a 5.1-cm infrarenal AAA and an associated HSK (Fig. 1). The isthmus of the HSK straddled the infrarenal aorta anteriorly and was supplied by a total of five renal arteries (Fig. 2). Arterial measurements revealed adequate proximal aortic and distal arterial seal zones. The common femoral and external iliac arteries were of sufficient size for device delivery.

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Figure 1 Abdominal and pelvic computed tomography angiography with multiplanar and three-dimensional reconstruction showing abdominal aortic aneurysm and horseshoe kidney.

Endovascular repair was performed in the operating room using a Zenith endograft (Cook Inc., Indianapolis, IN). Both common femoral arteries were accessed percutaneously and Perclose devices (Abbott Pharmaceuticals, Redwood City, CA) were pre-deployed. The Zenith bifurcated main body device (TFFB-22-82) was passed over a stiff guidewire from the right groin and

Figure 3 Intraoperative angiogram demonstrates the position of the endograft main body before deployment.

deployed (Fig. 3). This was followed by deployment of both limbs (TFLE-14-37, TFLE-12-54). Completion angiography revealed successful exclusion of aneurysm with no endoleak. All of the renal and hypogastric arteries remained patent (Fig. 4). The sheaths were then removed and Perclose devices successfully deployed.

Figure 2 3D-CTA reveals that the horseshoe kidney was supplied by five renal arteries.

Figure 4 Completion angiogram shows exclusion of the aortic aneurysm by the endograft with no evidence of endoleak. All renal and hypogastric arteries remain patent.

The patient did well and was discharged on postoperative day 3. His renal function remained stable with a creatinine level of 1.8 mg/dL on discharge. Abdominal CTA at 1 month follow-up revealed the endograft to be in excellent position; all renal arteries remained patent with no evidence of endoleak.

DISCUSSION

Congenital renal anomalies found in the setting of aortic surgery present specific technical challenges to the vascular surgeon. HSK is the most common renal anomaly occurring in up to 0.12% of aortic surgical procedures.⁴ Other less common anomalies include presence of an ectopic kidney and congenital renal vascular anomalies associated with supernumerary or accessory renal arteries.⁵ HSK is characterized by medial fusion of two kidneys either anteriorly or posteriorly to the aorta. Although renal fusion can occur at any level, an over-arching isthmus of parenchymal tissue connecting the two renal pelvises at the inferior poles occurs in more than 90% of cases.⁶ This renal anomaly is usually asymptomatic, associated with normal renal function,

and diagnosed incidentally on radiologic examination. Although a variety of classification schemes exist to describe HSK, the one most commonly used is the Eisendrath classification⁷ (Table 1). Our patient had type III HSK which makes up around 15% of the total HSK population.³

Difficulties associated with open AAA repair with coexisting renal anomalies have been previously documented.⁸ The first challenge involves the selection of the surgical approach.⁸ Midline laparotomy provides best exposure to the aneurysm and kidney, however, the presence of the renal isthmus affects both surgical exposure and proximal aortic control. Left retroperitoneal approach is preferred by many because it avoids interference with the renal isthmus and urinary tracts; however, access to the right iliac artery is limited and difficult. The second important issue is the decision of whether to preserve or resect the renal isthmus. Although resection may be necessary to achieve adequate exposure, the isthmus should be preserved, if possible, to avoid complications such as bleeding and urinary leak.⁸ Finally, although, in up to 30% of patients with HSK isolated renal arteries supply each side of the kidney and an additional branch supplies the isthmus, variability of vascular supply is common. At times, renal arteries supplying the HSK may arise from the aneurysm itself. A nontrivial decision as to whether to reimplant or ligate an accessory renal artery has to often be made.⁸

Endovascular AAA repair has been shown to be associated with decreased perioperative mortality and major morbidity.⁹ Percutaneous EVAR has been demonstrated to be safe and efficacious.¹⁰ Endovascular AAA repair in the setting of HSK was first described by Ferko et al in 1997.¹¹ Since then, there have been several reports of successful endovascular AAA repair in patients with HSK.³⁻⁵ In current practice, surgeons often assess their patients' suitability for EVAR based on their medical risk profile and anatomical factors. It is not known whether concomitant HSK independently increases the medical risk profile of a patient with an AAA.⁶ However, EVAR clearly offers an advantage of avoiding the technical complexity of open aneurysm repair. The challenge with EVAR in the setting of preexisting HSK revolves around the management of aberrant renal arteries. Coverage of accessory renal

Table 1 Eisendrath Classification of Horseshoe Kidney⁷

Classification	Description
Type I	One renal artery to each side of the kidney
Type II	One renal artery to each side of the kidney and an aortic branch to the isthmus
Type III	Two renal arteries to each side of the kidney and one to the isthmus
Type IV	Two renal arteries to each side of the kidney, with one or more arising from the iliac arteries, including the isthmus branch
Type V	Multiple renal arteries arising from the aorta, mesenteric and iliac arteries

arteries may be necessary to achieve an adequate proximal seal zone. Ruppert et al suggested that coverage of accessory renal arteries during EVAR is safe, especially when their diameter is less than 3 mm and there is no preexisting renal dysfunction.³ These authors have recommended consideration of EVAR in patients with AAA and HSK Eisendrath type I to IV.

Kaplan et al presented their experience with EVAR in patients with congenital renal vascular anomalies.⁵ There were 24 patients with multiple renal arteries, either with or without a renal parenchymal anomaly (HSK or solitary pelvic kidney). AAAs were successfully excluded in patients at a cost of coverage of 17 renal arteries. Despite imaging-guided detection of small segmental renal infarcts in some patients, there were no cases of long-term renal dysfunction, new onset, or exacerbation of hypertension. Based on their experience, these authors recommended consideration of EVAR in a patient with AAA and renal anomalies as long as main renal arteries and accessory renal arteries greater than 3 mm could be preserved.⁵

Imaging such as 3D-CTA is very useful in preoperative planning for EVAR because it allows for accurate measurement of aortoiliac diameters, lengths, and angles. These parameters together with assessment of presence and location of thrombus and occlusive disease facilitate choice of appropriate endograft and specific deployment strategy. In patients who have concomitant renal anomalies such as HSK, location and characterization of aberrant vascular supply to the kidney need to be determined. The relationship between the renal arteries and graft landing zones is then assessed. Finally, the decision as to whether to sacrifice one or more accessory renal arteries needs to be made. This decision is mainly based on whether or not an adequate graft seal zone can be obtained. Appropriate gantry angles to allow for optimal visualization of renal arteries at the landing zones need to be calculated so as to ensure optimal visualization of the seal zones during deployment. Virtual graft deployment into the 3D model is helpful because it allows for preoperative verification of deployment strategy.

3D computerized simulation of endovascular graft fitting and deployment based on reconstructed CT or magnetic resonance angiographic data have been shown to be superior to conventional arteriography in EVAR planning.¹² Its advantages include better parameter measurement, reduction of operating time, decrease in intravenous contrast, and reduction in radiation exposure. We used 3D-CTA to successfully plan

choice and deployment of our endograft. Appropriate gantry angulation (Fig. 3) allowed for visualization and salvage of all accessory renal arteries (Fig. 4).

CONCLUSION

Endovascular approach is safe and feasible in carefully selected patients with AAA and coexisting congenital renal anomalies. Careful preoperative planning is essential in successful endovascular management of abdominal aneurysm in these patients.

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