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CASE REPORT

A Novel Chimney Approach for Management of Horseshoe Kidney During EVAR

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Introduction: Abdominal aortic aneurysms (AAAs) with coexisting horseshoe kidney (HSK) can be difficult to repair, with variable blood supply from the aorta and iliac/mesenteric vessels. Endovascular aneurysm repair (EVAR) has become a popular, less invasive approach to aneurysm care, and a chimney approach to EVAR (ChEVAR) has expanded its use to more complex anatomy. It is mandatory to maintain adequate perfusion to the HSK and visceral branches as part of the treatment of an AAA.
Report: A 61-year-old male with an HSK was incidentally found to have an infrarenal AAA that measured 6 cm on a non-contrast computed tomography (CT) scan performed originally for a urologic complaint. A diagnostic angiogram was performed to define arterial anatomy and he was found to have a large inferior mesenteric artery (IMA) arising 1 cm above the level of the aneurysm. ChEVAR was performed to preserve the IMA and flow to the HSK with a completion angiogram revealing patent renal arteries, IMA, and no evidence of an endoleak. Follow-up CT imaging demonstrated a Type II endoleak that resolved upon partial nephrectomy for a right-sided transitional cell carcinoma with resection of the arterial blood supply feeding the Type II endoleak.
Discussion: IMA preservation via ChEVAR is technically feasible and was crucial to preserve blood supply via the IMA to the HSK. Partial nephrectomy treated the transitional cell carcinoma and resolved the Type II endoleak requiring no additional endovascular intervention. A unique treatment course demonstrated the benefits of less invasive interventions when repairing AAA with an HSK.

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INTRODUCTION

Horseshoe kidney (HSK) is a rare urogenital malformation and is infrequently associated with abdominal aortic aneurysm (AAA).[1] In the presence of HSK with an AAA, surgical interventions can be complicated with traditional open AAA repair. This is due to location of the isthmus of the horseshoe, adherence of the kidney to the aneurysm sac, and variable arterial and/or venous anatomy. Specifically, covering of the aneurysm sac by the isthmus of the HSK makes a transabdominal approach technically difficult and may be of great risk to the patient.[2]

Since an open repair can have a challenging surgical approach with risks of complications, EVAR is an attractive alternative.[2,3] Even though this is preferred, EVAR with coexisting HSK can still be challenging, depending on the specific arterial anatomy associated with the HSK. Because HSK is associated with multiple blood supplies from the aorta and iliac/mesenteric vessels, preservation of as much blood supply as possible is beneficial for renal function while not compromising the result of EVAR. The chimney strategy consists of utilizing parallel stents or stent-grafts adjacent to the endograft with the goal of maintaining adequate perfusion to the renal and visceral branches.[4]

With this in mind, a unique case is presented of a patient who underwent a complex EVAR repair requiring inferior mesenteric artery (IMA) preservation for blood flow preservation to a coexisting HSK that experienced an atypical treatment course postoperatively.

CASE REPORT

A 61-year-old male presented to the institution after an incidental finding of an infrarenal AAA. His medical history was significant for coronary artery disease, hypertension, congestive heart failure, and hyperlipidemia. A non-contrast computed tomography (CT) scan performed for a urologic complaint revealed an asymptomatic 6-cm AAA with an associated HSK as well as a bladder mass. Based on the Eisendrath classification system, it was determined to be a Type V HSK (Fig. 1).[5]

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Type I	One renal artery for each side of the horseshoe kidney	20%
Type II	One renal artery for each side with an aortic branch to the isthmus	30%
Type III	Two arteries for each side and one renal isthmus artery	15%
Type IV	Two arteries for each side with one or more arising from iliac arteries, including the isthmus branch	15%
Type V	Multiple renal arteries originating from the aorta and mesenteric and iliac arteries	20%

Figure 1. Horseshoe kidney classification system based on the vasculature supplying the horseshoe kidney.[5]

Because of the variable anatomy of the HSK, the decision was made to first proceed with a diagnostic arteriogram. The anteroposterior abdominal aortogram allowed identification of the superior mesenteric artery (SMA) and both renal arteries. There was a long infrarenal neck arising before the start of the aneurysm. Following this imaging, a Dyna CT scan using 75 mL of contrast revealed a large inferior mesenteric artery (IMA) arising approximately 1 cm above the level of the aneurysm with a neck length of 5 mm available below the IMA (Fig. 2). There was approximately 7 cm to the aortic bifurcation from the distal end of the IMA orifice. There were two main renal arteries on the left side. There was one main renal artery on the right side. There were some branches arising close to the level of the aneurysm and the iliac artery anatomy was normal.

It was determined that a chimney (Ch)EVAR approach would be a safe option following the imaging and it would not compromise the HSK, in which a large IMA was the alternative blood supply to the kidney. This was determined by selective angiography that demonstrated the IMA branches supplying the isthmus of the HSK.

Selective catheterization of the IMA with a 7F, 90-cm Pinnacle Destination sheath (Terumo Medical Corp., Somerset, NJ, USA) accessed via the left axillary artery. A 5 mm × 59 mm Atrium iCast stent (Maquet, Rastatt, Germany) was advanced into the IMA and left undeployed, resulting in the IMA snorkel being in place. Next, a 25 mm × 166 mm main body Medtronic (Minneapolis, MN, USA) Endurant device was selected in order to preserve all main renal arteries and deployed successfully. Finally, the IMA snorkel stent was deployed and the endograft deployment was completed. A completion angiogram revealed patent renal arteries, IMA snorkel stent-graft and no evidence of an endoleak (Fig. 3).

At 1 month, cross-sectional imaging showed the endograft and the IMA chimney stent relation to each other (Fig. 4). CT-angiography at 3 months revealed a widely patent IMA (Fig. 5). A Type II endoleak arising from one of the feeding right renal arteries was present (Fig. 6). This was further complicated by a concerning transitional cell carcinoma of the bladder that required transurethral resection of the bladder tumor and partial nephrectomy of the HSK on the right side with removal of the arterial blood supply leading to the Type II leak. The patient underwent a robotic nephroureterectomy. Follow-up imaging revealed resolution of the Type II endoleak. His aneurysm sac has been shrinking on subsequent surveillance imaging and he remains cancer-free over 2 years.

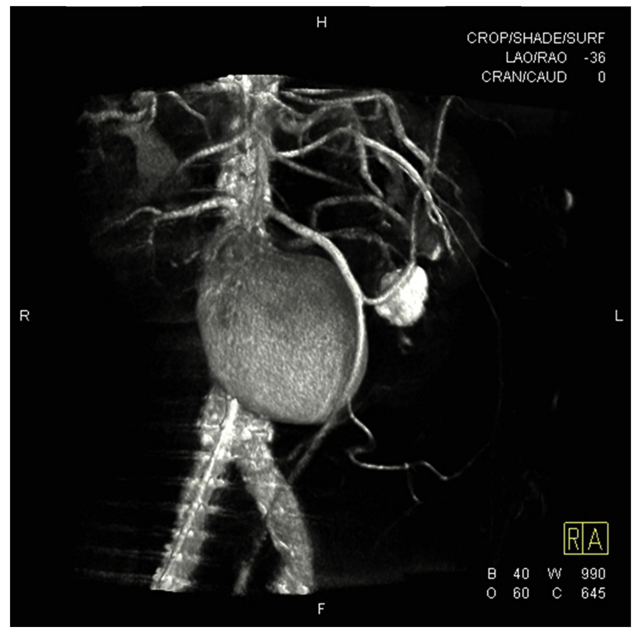

Figure 2. Dyna computed tomography scan demonstrating a large inferior mesenteric artery near the origin of the abdominal aortic aneurysm. The complex renal artery anatomy can be visualized as well.

Figure 3. Completion angiogram after placement of inferior mesenteric artery chimney stent and EVAR. There is no evidence of endoleak and the inferior mesenteric artery stent is widely patent.

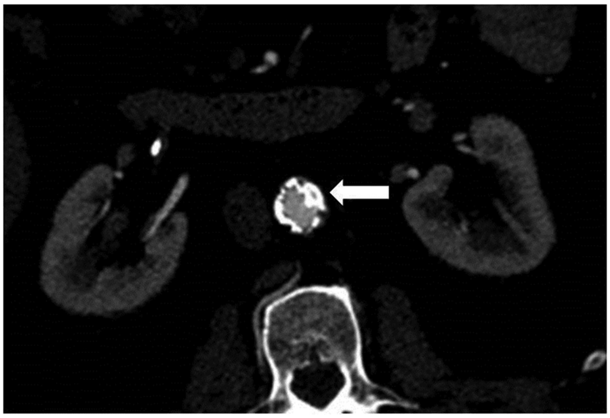

Figure 4. Cross-sectional imaging that demonstrates the interaction between the inferior mesenteric artery chimney stent and the proximal EVAR fixation. →: The location of the IMA chimney stent in front of the EVAR graft.

Figure 5. Computed tomography angiography (CTA) reconstruction demonstrating widely patent inferior mesenteric artery stent on 3-month follow-up CTA.

DISCUSSION

HSK is a relatively rare urogenital malformation occurring in 0.25% of the population and in 0.12% of individuals that undergo elective AAA repair.[1] When selecting a surgical option to fix an AAA with an HSK, it is important to consider the feasibility of various methods because of the highly variable arterial and venous anatomy of an HSK described by the Eisendrath classification system (Fig. 1).[5] With this variable anatomy, an important indicator to help determine whether an open procedure is feasible is the presence of an overarching isthmus of parenchymal tissue that connects at the inferior poles of the renal pelvises seen in 90% of HSK.[3] Even though there is no issue with this isthmus by itself, its presence with an AAA makes a transabdominal open repair difficult because of its location overlying the AAA.

Because the HSK can complicate open AAA repair secondary to an adherent aneurysm sac and variable arterial and venous anatomy, EVAR was believed to be a technically safer option for this patient. Previous literature discusses management of accessory arteries when undergoing an EVAR. Specifically, minimal postoperative consequences have been noted from covering main and accessory renal vessels <3 mm with an endograft.[1] Stenting over accessory renal arteries during an EVAR resulted in only small segmental infarcts in 21% of patients without any morbidity and mortality with only one in 24 patients having transient hypertension.[6] With this information in addition to the known importance of preserving the prominent IMA with several branches providing a majority of the blood flow to the HSK, the ChEVAR was believed to be technically superior to other options as it offered the least risk to the patient and did not compromise the result of the EVAR. The result of the decision to undergo a ChEVAR ultimately helped preserve flow to the HSK from the IMA. Nevertheless, without ChEVAR as a feasible option, it would be necessary to consider an open AAA approach as a possible alternative.

Finally, a complication that occurred after the EVAR was a Type II endoleak that arose from a right renal artery. Removal of the transitional cell carcinoma of the bladder with partial resection of the HSK on the right side removed all right-sided renal arteries and ultimately the feeding renal artery endoleak vessel. This allowed for resolution of the Type II endoleak and complete exclusion of the aneurysm. A partial nephrectomy allowed for treatment of the transitional cell carcinoma and resolution of the Type II endoleak. This is unique because the endoleak did not require any additional endovascular intervention. Furthermore, the

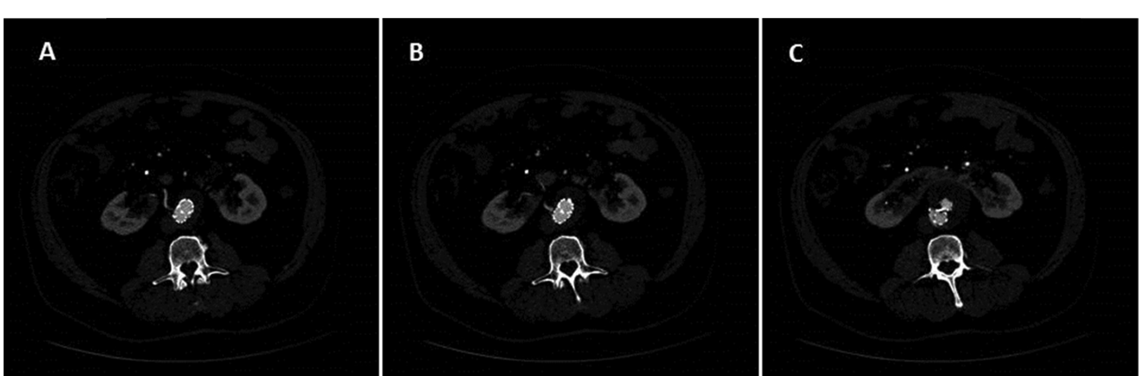

Figure 6. Type II endoleak arising from the right side of the horseshoe kidney. (A—C) The course of this artery leading to the endoleak. The partial nephrectomy resolved this problem.

ChEVAR allowed the patient to still have a functioning left portion of the HSK because it was not previously infarcted and provided a safer treatment course compared to the open approach. If the patient had an open retroperitoneal approach and had to undergo a subsequent nephrectomy, this would have most likely been a riskier procedure and more challenging course for the patient.

This case shows that a ChEVAR approach should be considered as a feasible option with minimal risk and successful outcomes based on the specific anatomy of each patient. The benefits of the ChEVAR have been shown because the HSK maintained adequate perfusion and prevented any downstream complications from the nephrectomy that could be seen in an open repair. It is hoped that this case offers a new technique by demonstrating that there was no additional risk to the patient while being able to maintain all of the possible arterial blood supply to the HSK.

CONFLICT OF INTEREST

None.

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