



## Operative Repair of Juxtra-Renal Abdominal Aortic Aneurysm with a Horseshoe Kidney Utilizing Cardiopulmonary Bypass

Marvin E. Morris<sup>1\*</sup>, Natasha Saiyed<sup>1</sup>, Marc A. Norris<sup>1</sup>, Neal C. Hadro<sup>1</sup> and Joseph E. Flack<sup>2</sup>

<sup>1</sup>Department of Surgery, Tuft University School of Medicine, USA

<sup>2</sup>Baystate Heart and Vascular, University of Massachusetts School of Medicine, Springfield, USA

### Abstract

Repair of abdominal aortic aneurysms in the presence of horseshoe kidney (AAA-HSK) can be technically challenging due to the variable renal arterial blood supply. Precise pre-operative knowledge of the anomalous renal perfusion is requisite for successful planning and treatment of AAA-HSK. We describe a case using a left heart cardiopulmonary bypass during operative repair of an 5.4 cm juxta-renal AAA-HSK to maintain renal perfusion during revascularization.

**Keywords:** Abdominal aortic aneurysms; Horse shoe kidney (AAA-HSK); Juxta-renal AAA-HSK

### Introduction

Operative challenges in the repair of HSK-AAA can frustrate even the most experienced surgeons. The variable arterial supply of the HSK-AAA, can involve ectopic or multiple renal arteries arising from the aorta, the iliac vessels or from the aneurysm itself, as described in the Eisendrath classification [1]. The extent of renal parenchyma perfusion by accessory renal arteries is a key determinant if these arteries need to be either bypassed, ligated or incorporated into the operative repair [2,3]. We report a case of a 64-year-old male presenting for elective repair of a 5.4cm abdominal aortic aneurysm in the setting of a congenital pelvic kidney with a Eisendrath V renal perfusion, with two distinct renal arteries originating from the aortic bifurcation. To maintain retrograde perfusion of the HSK, a left heart cardiopulmonary bypass circuit was utilized during operative repair.

### Case Presentation

This is a 64-year-old gentleman presenting for elective repair of an enlarging 5.4 cm juxtra-renal AAA with a pelvic midline HSK, with a recent increase in size from 4.8 to 5.4 cm. Preoperative CT angiography revealed two distinct renal arteries originating from the aortic bifurcation (Figure 1). In our opinion we did not have an endovascular approach suitable to his anatomy therefore we opted to perform operative repair while utilizing a mechanism to maintain perfusion of the HSK. In conjunction with our cardiac surgical team, we performed a partial right femoral artery-to-vein cardiopulmonary bypass for retrograde perfusion with a separate circuit in the iliac artery to maintain renal ostial perfusion during surgical repair.

Operative details include suprarenal aortic exposure for the short proximal aneurysm neck. Following distal aortic bifurcation exposure, a separate right groin incision was created to expose the right common femoral artery and vein. Arterial and venous perfusion catheters were placed for creation of a partial right femoral artery-to-vein cardiopulmonary bypass circuit. After systemic heparinization with 22,000 units, distal aortic clamping was obtained just above the aortic bifurcation, followed by a supra-renal aortic cross clamp, just below the superior mesenteric artery. Distal visceral perfusion during the proximal anastomosis was achieved by means of a right femoral artery-to-vein circuit. The iliac arteries were surgically controlled for creation of the distal anastomosis due to the inability to visualize the distal sewing ring. A separate catheter inserted in the right common iliac artery for ostial perfusion of the renal artery during the distal anastomosis. Ostial hypothermic renal artery perfusion was performed with cold blood infusion. A mean arterial pressure of 60 mmHg and average flow of 300-400 ml/min was maintained. Cessation of the cardiopulmonary bypass circuit occurred following hemostasis. The patient tolerated the operation

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#### \*Correspondence:

Marvin E. Morris, Department of Surgery, Tuft University School of Medicine, Baystate Vascular Services, 3500 Main St, Suite 201, Springfield, MA 01107, USA;

E-mail: dcmorris12@hotmail.com

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**Figure 1:** 3-D CTA reconstruction of a 5.4 juxtra-renal AAA, with pelvic HSK, with renal arteries originating from the aortic bifurcation (Eisendrath class V).

well and was discharged home on postoperative day six. He has not experienced any complications following his operation and his renal function remains unchanged at 1 year follow-up.

## Discussion

The frequency of HSK is 0.25% in the population and 0.12% in patients requiring abdominal aneurysm repair [4]. Repair of abdominal aortic aneurysms in the presence of a horseshoe kidney can be technically challenging due to the variable renal arterial blood supply and proportional perfusion of accessory renal arteries. Patients with horseshoe kidney can have ectopic or multiple renal arteries. They may arise from the aorta, the iliac vessels or from the aneurysm wall itself [5,6]. Logistical concerns include the variable renal arterial blood supply and the extent of renal parenchyma supplied by accessory renal arteries. Either the transperitoneal or retroperitoneal approach to open surgical repair is technically feasible, but morbidity and mortality are high, due to complex anatomy of the aberrant HSK [5-8]. These anomalous vessels can be challenging to manage in the operative setting. Therefore, when technically feasible, endovascular aneurysm repair (EVAR) is treatment of choice. EVAR is well established for HSK-AAA and is associated with decreased morbidity and mortality [9-12]. This was not an option in our case due to lack of requisite anatomy for either standard or fenestrated EVAR.

In our case we felt it was necessary to perfuse the kidney during operative repair. Both renal arteries originated from the aortic bifurcation, hence, distal aortic clamping would lead to unnecessary warm ischemia time. To mitigate the potential renal morbidity we opted to maintain HSK perfusion during repair. Logistically, partial cardiopulmonary bypass (CPB) preserves distal end-organ perfusion during aortic cross-clamping and is aimed to decrease ischemic time. Partial CPB is used during thoracic aortic surgery to provide perfusion to the spinal cord and visceral vasculature. During partial bypass, a portion of the stroke volume is deviated to the descending aorta. Pulmonary perfusion remains intact, thus maintaining the cardiac and respiratory functionality [13-15]. A femoral artery-femoral vein bypass carries the same functional principles as a left heart bypass. The circuit is composed of both venous and arterial cannulas. Following cannulation of the vein and artery, a portion of the right atrial blood volume is oxygenated and subsequently infused

into the femoral artery. A membrane oxygenator is needed due to drainage from the right atrium and full heparinization is required [12,14]. Selective visceral perfusion is performed by connecting the perfusion catheters secured to the Y limb, in our case to the renal artery ostia for retrograde perfusion.

## Conclusion

The therapeutic armamentarium of treatment of HSK-AAA is dynamic and reflects the complexity of arterial perfusion to the HSK-AAA. EVAR for AAA-HSK is the preferred approach and circumvents the operative challenges of surgical exposure, but even evolving technology with fenestrated devices may not be applicable to complex AAA-HSK anatomy. Partial CPB is a safe and effective approach to facilitate HSK perfusion during operative repair. It can serve as a novel addition to the existing repertoire of dynamic adjuncts used to repair this complex congenital anomaly.

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