Horseshoe kidney is a congenital anomaly characterized by medial fusion of the bilateral kidneys. Treatment for an abdominal aortic aneurysm (AAA) with a horseshoe kidney is a technical challenge because of the complex anatomy. We report a successful open surgical repair for a ruptured AAA with a horseshoe kidney. An aortic grafting was performed with division of the renal isthmus through a transperitoneal approach. In the case of a ruptured AAA, quick open surgery is the most reliable treatment. If a horseshoe kidney coexists, transperitoneal approach with division of the renal isthmus provides good surgical field for an aortic grafting.

Keywords: horseshoe kidney, abdominal aortic aneurysm, emergency surgery

Introduction

Horseshoe kidney, which is the most common of all renal fusion anomalies, occurs in 0.25% of population. In most cases, the isthmus connecting the lower poles of the bilateral kidneys lies over the abdominal aorta. Furthermore, horseshoe kidney is often accompanied by complicated arterial blood supply. As a result, vascular surgeons have to pay special attention to the abdominal anatomy in the case of surgical repair for an abdominal aortic aneurysm (AAA) with a horseshoe kidney. We herein report a case of a ruptured AAA with a horseshoe kidney. Our patient underwent an abdominal aortic grafting with division of the renal isthmus through a transperitoneal approach. We include a review of the previous literature and also discuss our surgical procedure.

Case Report

A 75-year old man, who could not move for an abdominal pain, was transferred to the emergency department of our hospital. Although an AAA had been previously detected, he left it without follow-up examinations. On admission, the systolic blood pressure was 80 mmHg with sinus tachycardia and his abdomen was obviously distended. Computed tomography (CT) showed an infrarenal AAA with a horseshoe kidney (Fig. 1 and 2). The AAA with a maximal diameter of 96 mm was accompanied by a large retroperitoneal hematoma including leakage of contrast medium, which suggested the presence of active bleeding (Fig. 1B). The renal isthmus of the horseshoe kidney covered the AAA (Fig. 1C). Although one renal artery for each side branched from the proximal neck of the AAA, any accessory renal arteries could not be detected (Fig. 1A). There was a stenosis in the left common iliac artery (Fig. 1D) and severe aneurysmal neck angulation (Fig. 2). Thereby, we decided to perform an open surgical repair for the ruptured AAA, which did not have suitable anatomy for endovascular aneurysm repair (EVAR).

In the supine position, a median laparotomy was made. Although a large hematoma existed in the retroperitoneal space, we could expose the proximal neck of the aneurysm without devastating bleeding. After clamping the abdominal aorta distal to the renal arteries, the retroperitoneum was widely opened. The isthmus of the horseshoe kidney, which covered the lower half of the AAA, was dissected longitudinally by using an electrical scalpel. Subsequently, the bilateral common iliac arteries were exposed and clamped. We could easily perform an aortic grafting using a bifurcated knitted Dacron graft (Gelsoft Plus Bifurcate Graft 16 × 8 mm, Vascutek Ltd., Renfrewshire, Scotland, UK) because of the good surgical field (Fig. 3A). Finally, the stumps of the horseshoe kidney were closed with continuous over-and-over sutures (3-0 VICRYL, Ethicon, New Brunswick, New Jersey, USA) and absorbable fibrin sealant patches (TachoSil, Takeda Company, Zurich, Switzerland) (Fig. 3B).
there was a risk of abdominal compartment syndrome due to massive bleeding into the retroperitoneal space, the patient underwent open abdominal management. To prevent adhesion between the small bowels and the abdominal wall, peritoneal lavage was performed every 48 h. The abdominal wall was closed on 10th postoperative day. After surgery, renal function was maintained without hemodialysis. Postoperative CT showed that there were no signs of urinary leak, renal infarction, and infection in the abdominal cavity. The patient was transferred to another hospital for rehabilitation on 53rd postoperative day and went back home 3-month postoperatively.

Discussion
Ruptured AAA is a lethal condition which needs prompt surgical treatment. However, the case of a ruptured AAA with a horseshoe kidney requires special consideration for the anatomical abnormalities. Horseshoe kidney is a renal fusion anomaly. The bilateral kidneys connect at their respective lower poles by a parenchymatous or fibrous isthmus, which usually lies over the abdominal aorta. In addition, the blood supply to the horseshoe kidney can be quite variable. It has been previously reported that approximately 60% of the patients with horseshoe kidneys had one or more accessory renal arteries.

The treatment for a ruptured AAA with a horseshoe kidney involves an open surgery and EVAR. When an open surgery is performed, a transperitoneal or retroperitoneal approach can be utilized. Although a retroperitoneal approach avoids interference with the isthmus of the horseshoe kidney, it is difficult to access to the right iliac artery. In addition, a retroperitoneal approach is unsuitable for the case of a ruptured AAA, because rapid control of the proximal neck of the aneurysm is needed in the emergent settings. Meanwhile, a transperitoneal approach is a versatile procedure, which can be used in both the elective and emergent settings. The abdominal aorta, bilateral iliac arteries, kidneys, and ureters are accessible through a transperitoneal approach. However,
the isthmus of the horseshoe kidney can disturb aortic reconstructive procedures. Whether to divide the isthmus of the horseshoe kidney is still controversial. In the case of an AAA with a horseshoe kidney, an aortic grafting with or without division of the renal isthmus has been previously reported. Complications related to division of the renal isthmus include urinary leak, infection, and bleeding. Because approximately 15 to 30% of the patients with horseshoe kidneys are accompanied by asymptomatic upper urinary tract infection, urinary leak after implanting a prosthetic graft is a life-threatening complication. When the renal isthmus is divided, urinary leak can occur both during and after surgery. Intraoperative urinary leak is a direct injury of the renal pelvies and ureters. It should be careful for the ureters, which cross the renal isthmus anteriorly and join each renal pelvis. In addition, to avoid severing the renal parenchyma around the ureter confluent part is also important. Meanwhile, urinary leak after division of the renal isthmus is associated with renal infarction. It has been previously reported that there was no complication related to division of the renal isthmus, including urinary leak, if the arterial blood supply to the horseshoe kidney was preserved. Horseshoe kidney is often accompanied by accessory renal arteries, which are regarded as functional end arteries. Therefore, ligation of the accessory renal arteries can cause renal infarction. Some previous reports recommended reconstruction of the accessory renal arteries with their diameter more than 2 mm.

In our case, the patient fell into a state of shock because of massive bleeding due to a ruptured AAA, which was accompanied by the horseshoe kidney. Furthermore, the renal isthmus widely covered the ruptured AAA. Therefore, we chose a transperitoneal approach with division of the renal isthmus. Indeed, in such emergent settings, a transperitoneal approach with division of the renal isthmus was more often performed than a retroperitoneal approach. According to our experience, division of the renal isthmus is a simple procedure which can be easily performed. Although it should be careful for the urinary tract and accessory renal arteries, dissection of the renal isthmus is usually not difficult because of the layer of fatty tissue around the horseshoe kidney. In addition, hemostasis of the stumps does not require special instruments. In our case, an absorbable fibrin sealant patch was effective for oozing from oversewed stumps.

Furthermore, vascular surgeons should pay attention to abdominal compartment syndrome as one of the critical complications of a ruptured AAA. In the case of a ruptured AAA, the mechanism of abdominal compartment syndrome is increased intra-abdominal pressure due to a large retroperitoneal hematoma and edema of the alimentary tracts. Thereby, abdominal compartment syndrome causes multiple organ failure, such as respiratory distress syndrome, renal failure, and intestinal necrosis. The effectiveness of open abdominal management and delayed abdominal closure for abdominal compartment syndrome has been previously reported in the case of a ruptured AAA. Considering the aspect of prevention of abdominal compartment syndrome, a transperitoneal approach is suitable for the case of a ruptured AAA with a horseshoe kidney, because open abdominal management or 2nd-look surgery is easily performed.

EVAR is recognized as a common treatment for AAAs with suitable anatomy. Furthermore, the effectiveness of EVAR for ruptured AAAs has also been reported. However, there are a few reports about EVAR for a ruptured AAA with a horseshoe kidney. If an AAA has suitable anatomy, such as the length and angle of the aneurysmal neck, and the diameter of the access vessels, the most serious concern is the presence of accessory renal arteries. Covering large accessory renal arteries by a stent-graft can cause renal infarction. In addition, although accessory renal arteries are regarded as functional end arteries, collateral flow has been clinically observed. Type II endoleaks caused by accessory renal arteries have been previously reported.

Conclusion
We successfully performed an open surgical repair for a ruptured AAA with a horseshoe kidney. An aortic grafting through a transperitoneal approach with division of the renal isthmus is suitable for such cases. Division of the renal isthmus, which is a simple and safe procedure, facilitates prompt vascular control.

Disclosure Statement
The authors have no conflict of interest.

References