Chapter 28
Aortorenal Bypass and Renal Artery Reconstruction

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Indications

Open operations for renal artery occlusive disease (RAOD) with renal artery repair (endarterectomy) and bypass have largely been replaced by endovascular techniques, including renal artery balloon angioplasty and stenting. Randomized controlled studies, including the CORAL trial, although heavily criticized, have not provided evidence in favor of revascularization. The ASTRAL trial failed to show any improvement in systolic blood pressure, creatinine, or glomerular filtration rate (GFR) when compared to medical therapy, while the CORAL study demonstrated a modest blood pressure improvement and no difference in creatinine or GFR. Thus, the indications for intervention into renal artery stenosis (renovascular hypertension and ischemic nephropathy) have been heavily scrutinized and are now restricted to very specific indications. In this context, correction of renal arterial inflow stenosis is reserved for very select patients with resistant hypertensive patients who have failed maximal medical therapy, have worsening renal function, and/or unexplained congestive heart failure. Expectantly, the number of renal artery interventions has decreased, and the performance of a surgically isolated renal artery bypass, for occlusive lesions, is now relatively rare. While uncommonly performed in isolation, the practicing vascular surgeon still needs to be familiar with the techniques and conduct of renal artery revascularization procedures, especially in the setting of concomitant open aortic reconstructions or aortic pathology involving the renal branches.

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The primary indication for open aortorenal bypass in modern vascular surgery continues to be needed for renal artery reconstruction during open aortic repair. This would include those patients with suprarenal abdominal aortic aneurysm (AAA) that require bypass, patients with infrarenal AAAs with significant RAOD, and those patients with aortoiliac occlusive disease (AIOD) requiring aortofemoral bypass who also have RAOD. Patients with bilateral moderate severe (60–80% stenosis) or severe disease (>80% stenosis) in the setting of severe hypertension, especially with evidence of excretory renal function impairment like azotemia, should be considered for concomitant bypass at the time of their aortic reconstruction. Performing simultaneous renal reconstruction during AAA and AIOD repair has not been shown to increase mortality, but there is a notable increase in morbidity and postoperative dialysis rates, seen more so in AIOD than with AAA. For combined renal artery stenosis and AAA, preoperative percutaneous transluminal renal artery angioplasty (plus stenting), prior to the open repair, remains an option; however, there is no outcome advantage compared to those with combined open renal artery reconstruction and AAA repair.

Additional indications for renal artery reconstruction also exist. There continues to be a need for open aortorenal bypass in select patients with renal artery aneurysms (different chapter), mid-aortic syndrome, and pediatric patients with hypoplastic renal artery lesions. These latter procedures should be performed at specialized centers. Also, renal artery bypass will be required in debranching abdominal operations performed very selectively for high-risk patients with suprarenal aneurysms or thoracoabdominal aneurysms. Lastly, isolated renal artery reconstruction may be required in the setting of failed endovascular interactions, particularly if there is an isolated solo kidney.

Preoperative Planning

Initial determination of the extent of renal artery stenosis is performed with renal Duplex ultrasound. Peak systolic velocity (PSV) of >200 cm/s is associated with >50% stenosis, and the ratio of >3.5 of renal artery to aorta PSV correlates with >60% stenosis. If unable to perform renal artery duplex, computed tomography angiography (CTA) or magnetic resonance angiography (MRA) may also be of use, although CTA does require iodinated contrast and should be used cautiously in the setting of renal dysfunction. CTA and MRA can also aid in identifying anatomy, including orientation of the arteries, as well as the presence and location of renal artery branches and accessory vessels. Renal artery duplex with measurement of a resistive index can be a surrogate for determining the amount of intraparenchymal renal disease present, which may assist in determining who may improve from surgical revascularization.

Preoperative Decision-Making

In the adult patient, two graft options are typically used for renal bypass: autologous saphenous vein and synthetic polytetrafluoroethylene (PTFE) graft. The selection of conduit depends upon the indication for the procedure and if the bypass is being performed in the setting of a concomitant operation. Saphenous vein may be utilized in isolated renal artery reconstruction; however, PTFE is generally used for cases of combined aortic reconstruction. The inflow is typically the infrarenal aorta or the aortic graft; however, there may be instances in which the bypass may originate from the iliac artery. This includes those patients with advanced aortic arteriosclerosis, patients with prior aorto-aortic reconstructions, congenital aortic coarctations, and debranching operations in the treatment of thoracoabdominal or suprarenal aneurysm disease.

In general, the authors favor a bypass procedure (as opposed to endarterectomy) when the need for renal artery revascularization exists; nevertheless, there are times in which renal artery endarterectomy, either direct or via an eversion technique, may be preferred. Overall, equivalent outcomes have been reported.

Surgical Anatomy and Exposure

Two main approaches are used for exposure of the origins of the renal arteries in the context of bypass, the medial visceral rotation (MVR) and the infra-mesocolic approach. Selection of approach will depend on the extent of the suprarenal aorta that needs to be exposed and whether the distal aspect of the main renal artery will require exposure. The infra-mesocolic approach is suitable for the majority of renal artery reconstructions with the medial visceral rotation reserved for those instances with which very distal reconstructions are being contemplated, most commonly on the right.

Infra-mesocolic Approach: (Left and Proximal Right)

The abdomen and peritoneal cavity can be opened via a midline incision extending up to xiphoid process. A supraumbilical transverse incision is also possible. In the infra-mesocolic approach, the small bowel is retracted to the patient's right, and the colon retracted superiorly, allowing a midline exposure of the retroperitoneum (Fig. 28.1). The posterior peritoneum to the right of the aorta is incised. The duodenum is retracted to the right exposing the avascular plan under the pancreas. Careful dissection should be conducted as mesenteric vessels may be encountered at this level before the avascular plane is entered. The incision may need to be extended along the inferior border of the pancreas to obtain adequate posterior exposure. The

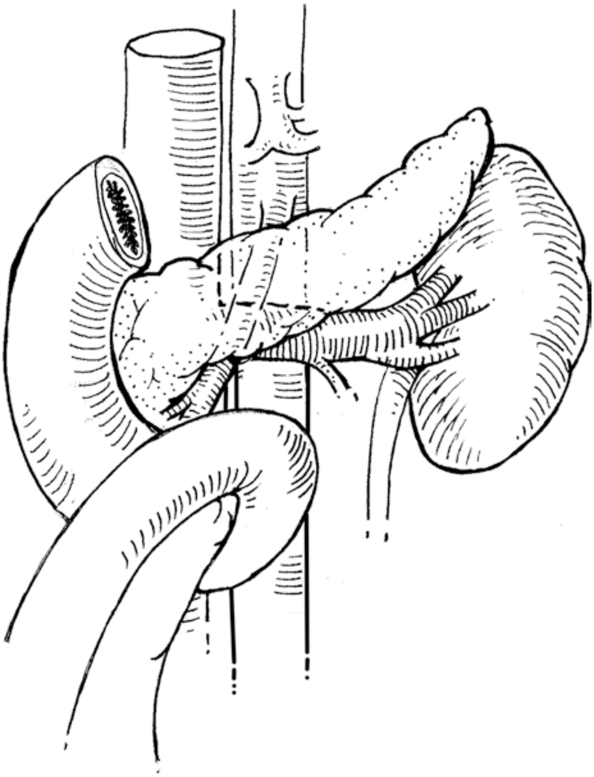

Fig. 28.1 Infra-mesocolic approach with the small bowel retracted to the right, and the colon retracted superiorly, allowing a midline exposure of the retroperitoneum

left renal vein is then mobilized, and the adrenal, gonadal, and lumbar veins ligated. The left renal vein can then be reflected superiorly (most commonly) or inferiorly, to aid in exposing the artery. (Fig. 28.2). The right renal artery at its origin can be exposed through the same approach, limited to the first 3–4 cm of the proximal right renal artery. The proximal portion of the right renal artery is exposed by retracting the left renal vein superiorly and the vena cava to the right (Fig. 28.2). The aorta which generally is used as the origin for both the right and left renal bypass is exposed for 5–8 cm below the renal artery origin down to or just below the origin of the inferior mesenteric artery. If a vein graft is being used, perioperative vein mapping is undertaken to identify the best available segment of greater saphenous vein. The author favors a distal end-to-end anastomosis with the distal anastomosis spatulated (Fig. 28.3). The aortic anastomosis to limit arterial ischemia to the kidney is performed first. The aorta is cross-clamped, both proximally and distally (or alternately, in a non-diseased aorta or with an aortic graft, a side-biting clamp may be utilized), and an aortotomy is made on the anterolateral aspect of the aorta with the aortotomy length extending 2.5× the vein caliber. The vein is slightly spatulated and the anastomosis carried out with 5-proline suture with the initial suture at the apex of the spatulated graft and the superior segment of the aortotomy (Fig. 28.4).

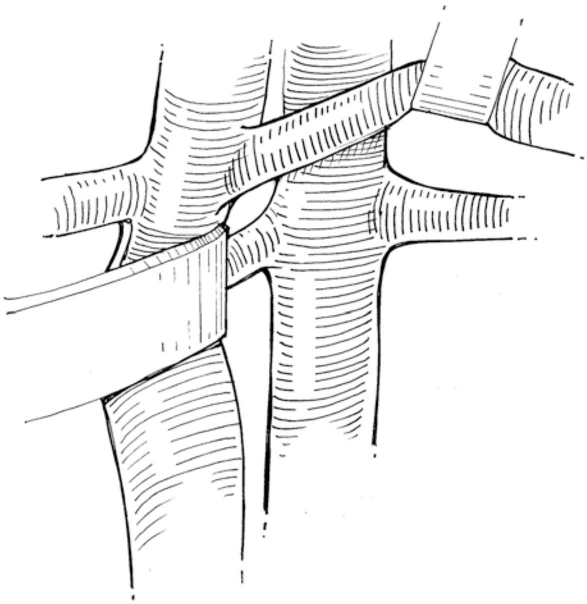

Fig. 28.2 Retraction of the inferior vena cava to the right and the left renal vein superiorly allowing exposure of the origins of both the right and left renal arteries

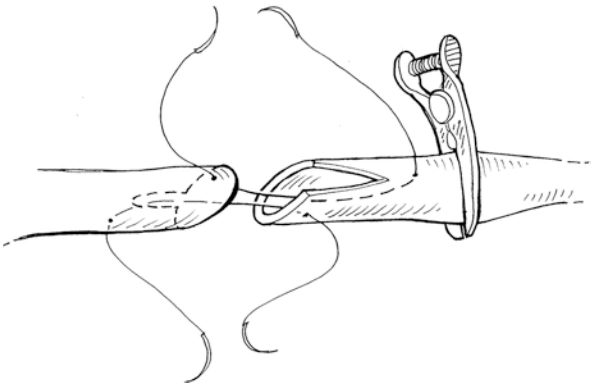

Fig. 28.3 Performance of an end-to-end spatulated renal artery anastomosis

Following the anastomosis, the flow in the aorta is restored, the vein graft is distended, and the conduit is assessed for orientation and length. Additionally, a side-biting clamp may be useful to avoid a pressured vein graft and allow for technically easier distal anastomosis. The diseased renal artery stump will need to be suture ligated. The distal anastomosis is accomplished via a spatulated technique (Fig. 28.3) with the spatulation of the renal artery on the anterior aspect and spatulation of the vein (or graft) on the posterior aspect (Fig. 28.4). The conduct of the bypass is similar whether vein graft or PTFE graft is utilized. In combined procedures, the author favors the use of PTFE graft with the only additional caveat that the proximal bypass anastomosis to the main body of the graft has been completed prior to the

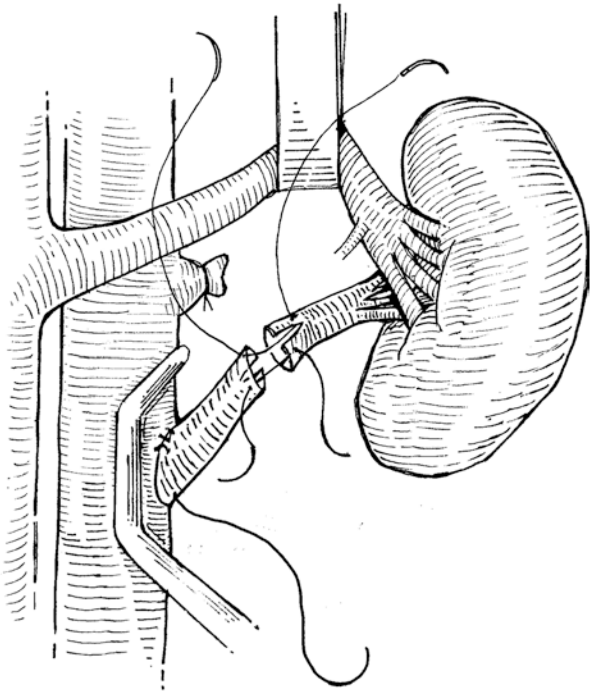

Fig. 28.4 Performance of the proximal anastomosis of a left aorto-renal bypass off the aorta (side-biting aortic clamp utilized) with spatulation of the distal anastomosis

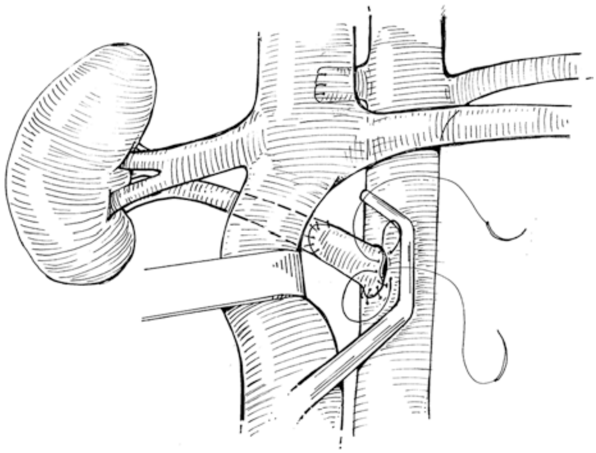

Fig. 28.5 Performance of the proximal anastomosis of a right aorto-renal bypass off the aorta (side-biting aortic clamp utilized) with a completed distal spatulated anastomosis posterior to the inferior vena cava

performance of the proximal aortic anastomosis. The operation on the right can be performed through the same exposure, accomplished with careful retraction of the left renal vein superiorly and the vena cava to the patient's right (Fig. 28.5). This approach should be for disease confined to the very proximal orifice of the right renal artery. The bypass is tunneled inferior to the IVC (Fig. 28.5).

Medial Visceral Rotation (Right Renal Artery Bypass and Distal Exposure of the Left Renal Artery)

The MVR allows for increased proximal aortic exposure along with improved exposure of the distal renal artery and its branches. Medial visceral rotation is accomplished through a midline abdominal incision. During the right MVR, the peritoneal reflection of the ascending colon at the white line of Toldt is excised, and the colon reflected anteromedially. The duodenum and pancreatic head are Kocherized and reflected medially, exposing the right kidney and Inferior vein cava (IVC) (Fig. 28.6). The right renal vein, which overlies the artery, must then be circumferentially cleared from the inferior vena cava junction. Any small branches should be ligated, including lumbar veins, which will aid in retraction of the IVC. The right renal vein can then be retracted superiorly to expose the artery (Fig. 28.6).

The left MVR requires the peritoneal reflection of the descending colon at the white line of Toldt to be excised, and the colon reflected anteromedially, exposing the left kidney. The left renal vein, lying anterior to the artery, can then be further

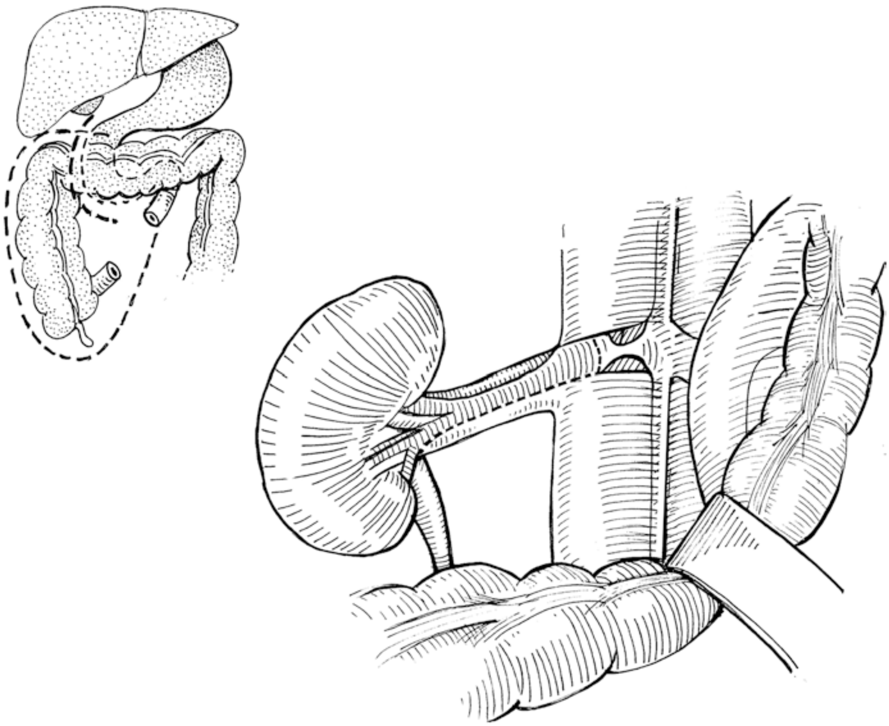

Fig. 28.6 Right medial visceral rotation with the location of the incision (insert) and mobilization of the right colon and duodenum to the left with exposure of the inferior vena cava and the distal right renal vessels (main diagram)

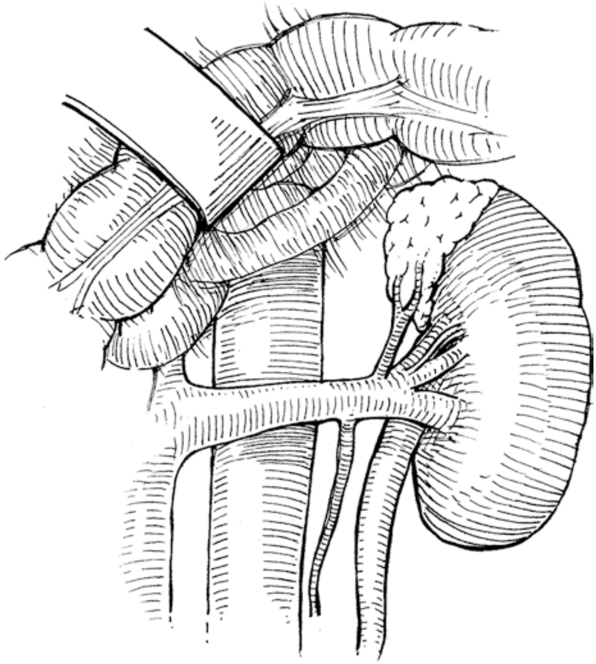

Fig. 28.7 Left medial visceral rotation with mobilization of the left colon anteromedially with exposure of the left renal vessels (the artery, not shown, lies just posterior to the vein)

mobilized by ligating the adrenal, gonadal, and lumbar branches and reflecting it either superiorly or inferiorly (Fig. 28.7). In practice, when an abdominal aortic aneurysm is being performed concomitantly with the left renal artery reconstruction, the authors prefer the left flank retroperitoneal approach (see chapter on AAA), and the renal artery bypass, typically performed with PTFE graft, is kept very short (<1 cm). There is a tendency for the bypass graft to be long, which once the retroperitoneal contents are returned to their anatomic position, the graft may prove to be redundant and prone to kinking. Whether the exposure is accomplished via the MVR approach or via the infra-mesocolic approach, the concepts and the technical exercise of the renal artery bypass remain the same.

Complications

The most common complications after renal artery bypass are early renal dysfunction, bypass graft occlusion or thrombosis (1%), unchanged or worsening hypertension, and recurrent stenosis. Early bypass graft occlusion is most often technical in nature. The mortality rate of renal artery bypass when combined with aortic reconstruction varies between 4.7% and 8.3%. Advanced age, female gender, chronic renal failure, bilateral procedures, congestive heart failure, and chronic lung disease were all independent risk factors of in-hospital mortality. Patency, while difficult to accurately assess due to the absence of routine surveillance, has been reported to be 95% at 3–5 years post bypass. Patency rates appear to be equivalent between saphenous vein bypass and prosthetic bypass.

Take-Home Points

1. Renal artery open reconstructions are less commonly performed, restricted now to specific indications owing to randomized trials failing to show an advantage or benefit to revascularization interventions. As such, isolated renal artery reconstructions are less commonly performed and are typically carried out now in the setting of concomitant aortic reconstruction.
2. Open renal revascularization is still utilized in instances of recurrent disease not amenable to repeat intervention, failure of attempted endovascular intervention, and anatomic pattern of disease which does not render itself to endovascular intervention. Specific disease states including renal artery aneurysm and mid-aortic syndrome may require open bypass or revascularization.
3. Key concepts of renal revascularization include (1) the aorta (or the aortic graft) primarily serves as the inflow (although alternate inflow sources can be used); (2) bypass can be performed with vein or PTFE with the caveat of a spatulated anastomosis; and (3) the exposure of the majority of renal artery bypasses is accomplished via a infra-mesocolic approach with the medial visceral rotation reserved for specific indications or considerations.

References

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