15.4.1 Anatomy

The kidneys are paired organs situated posteriorly behind the peritoneum on each side of the vertebral column and are surrounded by adipose connective tissue. Each kidney has a characteristic shape with a superior and inferior pole, a convex border placed laterally, and a concave medial border. Superiorly they are level with the upper border of the twelfth thoracic vertebra, inferiorly with the third lumbar. The right kidney is usually inferior due to the volume of the liver, while the left is a little longer and narrower and lies nearer the median plane. The long axis of each kidney is directed inferolaterally and the transverse posterolaterally.

Each kidney is about 11 cm in length, 6 cm in breadth, and 3 cm in anteroposterior dimension. Average weight is 135 – 150 g in adults. The hilum of the kidney is an anteromedial deep vertical fissure containing the renal vessels and nerves as well as the renal pelvis of the ureter. The relative positions of the main hilar structures are the vein anterior, the artery intermediate, and the pelvis posterior. Commonly, an arterial branch enters behind the renal pelvis and a renal venous tributary often leaves the hilum in the same plane.

The kidney and its vessels are embedded in perirenal fat, which is thickest at the renal borders and prolonged at the hilum into the renal sinus. Fibrous connective tissue surrounding this fat is condensed as renal fascia. At the lateral renal borders, the two layers of renal fascia fuse; the anterior extends medially in front of the kidney and its vessels to merge with connective tissue enclosing the aorta and inferior vena cava, but it is thin and does not ascend above the superior mesenteric artery. The posterior layer passes medially between the kidney and the fascia on quadratus lumborum and psoas major, attaching to this fascia at the lateral and medial borders of the psoas and to the vertebral and intervertebral discs. A deeper stratum unites the anterior and posterior layers at the medial renal border and is pierced by renal vessels. Renal fascia joins the renal capsule by numerous trabeculae traversing the perirenal fat and is strongest near the lower pole. Behind the renal fascia is a mass of fat the pararenal body. The kidney is held in position partly by renal fascia but principally by the apposition of neighboring viscera. The kidney has a thin capsule, composed of collagen-rich tissue with some elastic and non–striated muscle fibers. The organ itself has an internal medulla and external cortex.

The renal arteries are two large vessels that branch laterally from the aorta just below the inferior mesenteric; both cross the corresponding crus at right angles to the aorta. A single artery to each kidney is present in about 70% of individuals but they vary in their level of origin (the right often being superior) and in their caliber, obliquity, and precise relations. The right renal artery is longer and often, higher, passing posterior to the inferior vena cava, right renal vein, head of the pancreas and descending part of the duodenum. The left is a little lower; it passes behind the left renal vein, the inferior mesenteric vein may cross the body of the pancreas and splenic vein anteriorly. In its extrarenal course, each renal artery gives one or more inferior suprarenal
arteries and branches that supply perinephric tissue, the renal capsule, pelvis, and the proximal part of the ureter; near the renal hilum, each artery divides into an anterior and posterior division, the primary branches of which (segmental arteries) supply renal vascular segments. Accessory renal arteries are common (30% of individuals), usually arising from the aorta above or below the main renal artery and following it to the renal hilum.

The renal veins are vessels of large size and lie anterior to the renal arteries and open into the inferior vena cava almost at right angles. The left is three times the right in length (7.5 cm and 2.5 cm, respectively); it crosses the posterior abdominal wall posterior to the splenic vein and body of pancreas and, near its end, is anterior to the aorta, just below the origin of the superior mesenteric artery. The left testicular or ovarian vein enters it from below and the left suprarenal vein, usually receiving one of the left inferior phrenic veins, enters it above but nearer the midline. The left renal vein enters the inferior vena cava a little superior to the right. The right renal vein is behind the descending duodenum and sometimes the lateral part of the pancreas (Sampaio 1996).

15.4.2 Iatrogenic Vascular Injuries

Iatrogenic main renal artery injuries with perforation or rupture are rare and almost exclusively reported after renal artery angioplasty or stenting with an incidence of 1.6% (Morris and Bonnevie 2001). One case of an iatrogenic renal artery perforation as a complication of cardiac catheterization has been reported (Bates et al. 2002). Since most iatrogenic renal artery lesions occur during endovascular procedures, there are no reports on the clinical symptoms, but only on the angiographic findings (Fig. 15.4.1). Arteriovenous fistulae, pseudoaneurysms, arterial dissection, or contrast extravasation are the possible radiological findings in these traumatic vascular lesions. Traditional therapy for renal perforation has been renal artery ligation followed by bypass grafting or nephrectomy, but nowadays the treatment for acute iatrogenic rupture of the main renal artery is balloon tamponade. The size of the angioplasty balloon chosen for tamponade should be 1 mm smaller in diameter than the size of the balloon or stent that caused the rupture. The balloon is fully inflated without the use of a manometer in all cases. Time of the procedure varies; a maximum of 3 min, followed by rapid deflation, and a repeat after 2 min is effective in most cases. However, in some cases inflation may need to last up to 10 min, while in other cases a single 1-min balloon inflation is enough. After the treatment of each ruptured renal artery, a selective renal digital subtraction angiogram should be performed to exclude further extravasation. However, in case of failure immediate availability of a stent graft is vital.

Patients with iatrogenic operative injuries are strikingly different from those with penetrating, blunt, or catheter-related vascular trauma. Renal vessels are vulnerable during oncologic procedures. Factors that increase technical difficulty are previous operation, tumor recurrence, radiation exposure, and chronic inflammatory changes. Renal vein injuries during elective abdominal operations are a serious complication with significant morbidity. Most patients with operative venous injuries have partial lacerations that can be managed with relatively simple techniques, such as venorrhaphy and patch angioplasty with autologous vein of ePTFE graft if venorrhaphy is not possible because of significant vessel narrowing (Oderich et al. 2004).

15.4.3 Renal Transplantation

The orthotopic kidney is protected against external force by muscles, Gerota’s fascia, and perinephric fat. A renal graft is located in the lower pelvis in the iliac fossa through a retroperitoneal incision anastomosed to the iliac artery and vein and therefore is more susceptible to injury, especially from direct blows to the abdomen.