CT Diagnosis of Renal Artery Injury Caused by Blunt Abdominal Trauma

Anthony R. Lupetin1
Brent L. Mainwaring
Richard H. Daffner

Controversy exists about the sensitivity of CT in the diagnosis of occlusion of the renal artery or one of its branches after blunt abdominal trauma. We report 10 cases in which contrast-enhanced CT was used to diagnose correctly either main (seven cases) or segmental (three cases) posttraumatic renal artery occlusion. The abnormality was proved angiographically and/or surgically in all cases. CT showed the absence of a nephrogram in the devascularized portion of the kidney in all 10 cases. A pyelogram was not shown on CT in the seven patients in whom the main renal artery was occluded, but was present in the three patients who had segmental arterial lesions. Termination of enhancement within the affected artery (renal artery cutoff sign) was observed in one patient, and a thin, peripheral rim of cortical enhancement in an otherwise unenhanced renal segment (rim sign) was observed in three patients. Retroperitoneal hematoma with renal displacement was present in nine patients.

Our experience suggests that the absence of a nephrogram on contrast-enhanced CT scans is a useful sign of main or segmental renal arterial occlusion in patients with blunt abdominal trauma.

AJR 153:1065–1068, November 1989

Authors of recent reports recommend CT as the initial diagnostic procedure of choice for the assessment of renal injury after blunt abdominal trauma because of its specificity compared with that of excretory urography [1, 2]. Most authors agree that CT is of value for delineating minor and major renal parenchymal disruption, urine extravasation, renal and perirenal hematomas, and associated abdominal and retroperitoneal injuries [1–11]. However, opinion is divided as to whether CT can be used accurately without angiography to detect posttraumatic occlusion of the main renal artery or of a segmental branch [11].

To evaluate the role of CT in these cases, we retrospectively studied the CT findings in 10 patients in whom occlusion of the main renal artery or one of its segmental branches caused by blunt abdominal trauma was proved by angiography and/or surgery.

Materials and Methods

All 10 renal arterial injuries (six left-sided, four right-sided) occurred in young patients (ages 15–23 years, eight male, two female) admitted for evaluation of suspected multisystem trauma. A deceleration injury occurred in nine cases (six motor vehicle accidents, three falls). In one case, the patient was crushed by a truck while repairing a tire.

CT studies were performed on the Picker 1200 SX (Picker International, Cleveland, OH) (one case, 10-mm sections), Siemens DR3 (three cases, 8-mm sections), or Siemens DRH (Siemens Medical Systems, Inc, Iselin, NJ; six cases, 8-mm sections) scanners after nongastric administration of 750 ml of dilute oral contrast medium and IV injection of a 100-ml bolus of 76% iodinated contrast medium. Dynamic incremental CT was used in seven cases; nondynamic CT was used in three cases.
Eight patients were studied shortly after admission because of hematuria and/or a nonfunctioning kidney shown by excretory urography. CT was delayed for 24 hr in one patient who required emergency laparotomy for bile peritonitis and for 72 hr in another patient who underwent emergent surgery for a colonic perforation. These patients developed postoperative hypertension and hypotension, respectively, necessitating CT evaluation.

Angiography was performed in four patients. A flush abdominal aortogram showed occlusion of the main renal artery in two patients, and a selective renal arteriogram showed a segmental arterial occlusion (one ventral, one dorsal) in two patients. An arteriogram was not obtained before surgery in six patients because of the convincing nature of the CT findings.

Seven patients underwent emergency retroperitoneal exploratory surgery on the basis of CT findings (two of these patients also had confirmatory angiography preoperatively). Avulsion of the main renal artery was discovered in five patients, necessitating nephrectomy. Thrombosis of the two renal arteries supplying a left kidney was found in one case. An attempted surgical revascularization in this case was considered a failure on the basis of a postoperative nuclear medicine flow study. Avulsion of the ventral segmental branch of the left main renal artery was found in one patient.

Results

The CT findings depended on the location of the renal arterial occlusion. When the main renal artery (or arteries) was occluded (seven cases), no contrast enhancement of the renal parenchyma (CT nephrogram) or contrast medium excretion (CT pyelogram) was identified (Figs. 1A and 1B). A thin, peripheral rim of cortical enhancement in an otherwise unenhanced renal segment (rim sign) was visible in only one of seven patients with a main renal artery occlusion (Fig. 2). In three patients in whom the main renal artery was patent but a major segmental branch (two ventral, one dorsal) was occluded, parenchymal enhancement of the unaffected segments was observed along with a CT pyelogram (Fig. 3). CT scans of two of these three patients showed a rim sign along the periphery of the affected ventral segment but otherwise did not show CT nephrogram (Fig. 4). Actual termination of enhancement within the affected artery (renal artery cutoff sign) was observed convincingly in only one patient in whom contrast medium extravasated into the retroperitoneum (Fig. 5). Urine extravasation was not present in any patient initially, although one patient developed a urinoma after admission. Retroperitoneal hematoma with resultant anterior or superior displacement of the injured kidney was present in nine of 10 patients. In only one patient was the injured kidney smaller than normal.

CT and angiography were equal in their usefulness for predicting the location of the injured portion of the renal arterial system in the four patients in whom preoperative angiography was performed. Although CT did not specifically show the point of obstruction in the renal artery or its branches that was shown angiographically, the location of the occlusion could be inferred by determining whether the distribution of the unenhanced parenchyma was total or segmental. CT showed retroperitoneal hematoma that was not visible on angiography in two cases. Angiography did not reveal any abnormalities that were not shown with CT.

Discussion

A significant renal injury occurs in 8–10% of patients after blunt abdominal trauma; in 1–3% of these patients, a renal artery is occluded [1, 3, 9]. In a review of 250 cases of posttraumatic renal arterial occlusion, Clark et al. [12] noted...
Fig. 3.—Posttraumatic thrombosis of ventral branch of left renal artery.
A, Enhanced CT scan (upper pole of kidney) shows absence of nephrogram anteriorly in devascularized segment (arrows). CT nephrogram is present in dorsal renal segment, as is CT pyelogram (p). (a = aorta, H = hematoma.)
B, Enhanced CT scan (lower pole) shows absence of a nephrogram in devascularized lower pole cortex (lc). Rim sign is present laterally (arrows). Large hematoma (H) separates kidney and psoas muscle (P). (a = aorta, arrowhead = ureter.)
C, Selective renal arteriogram shows lack of arterial flow to inferior part of kidney.

Fig. 4.—Posttraumatic occlusion of ventral branch of left renal artery. Dynamic CT scan shows rim sign defining periphery of otherwise nonenhancing lower pole of left kidney (arrows). (a = aorta, f = renal sinus fat.)

A left-sided predominance with the lesion typically occurring after a deceleration injury. At surgery, the arterial injury was thrombosis (52%), avulsion (12%), branch injury (8%), intimal flap (7%), spasm (4%), laceration (3%), stenosis (2%), or unknown (19%). The lesion was bilateral in 22% of patients and accompanied by a significant other abdominal injury in 45% [12].

Authors of previous reports have generally supported the concept that CT can be used specifically to diagnose posttraumatic renal artery occlusion [6-10], although at least one authority dissented [11]. Including our cases, 18 cases have been reported in which CT was used to diagnose correctly renal arterial occlusion due to blunt trauma [6-10]. Seven additional cases were reported in an article that claimed five of seven renal arterial lesions were missed by CT scans; these cases were not included because of lack of detailed clinical or radiographic documentation in the publication [11]. In the eight well-documented, previously reported patients (nine injured kidneys), there were seven main renal artery injuries and two segmental lesions. A left-sided predominance occurred (five of nine lesions). In all seven patients with main renal artery injuries, a CT pyelogram was absent. Five patients lacked a CT nephrogram, and in two patients, minimal, patchy enhancement was observed. A rim sign was evident in four patients, and a renal artery cutoff sign was seen in two patients. The injured kidney was smaller than normal in one patient, and associated retroperitoneal hematoma was visible in four patients. In both previously reported cases of segmental renal artery occlusion, a CT pyelogram was observed. The devascularized segment was defined by its nonenhancement. A rim sign, renal artery cutoff sign, or other abnormality was not present in either case.

Therefore, based on our experience and well-documented previous reports, when the main renal artery is occluded because of blunt trauma, the key findings on contrast-enhanced CT scans are the absence of renal parenchymal enhancement (CT nephrogram) and contrast medium excretion (CT pyelogram). Rarely a minimal, patchy CT pyelogram without CT nephrogram may be observed [7, 8], resulting from a small amount of contrast medium reaching the parenchyma via the partially occluded renal artery. We did not observe this phenomenon in our series, but it was present in two of eight previously reported cases [7, 8]. The presence of a few small zones of parenchymal enhancement on CT in an otherwise unenhanced kidney without a pyelogram should not obscure the diagnosis, although arteriography may be necessary to prove the diagnosis.

In the presence of a segmental arterial occlusion, a pyelogram may be present on CT as a result of excretion of contrast
medium by the adjacent uninjured portion of the kidney. However, the shape and location of the devascularized segment defined by the zone of parenchymal nonenhancement should allow a specific diagnosis of a ventral or dorsal segmental arterial occlusion based on the segmental renal anatomy [13].

The presence of a thin, peripheral region of cortical enhancement on CT (rim sign), first described in patients with global renal infarction due to nontraumatic causes [14], is a less reliable indicator of posttraumatic vessel occlusion. This finding was observed in only three of 10 cases in our series and in four of eight previously reported cases [6–10]. It indicates the presence of an intact collateral arterial supply provided by capsular, peripelvic, or perireticular arteries that may or may not remain patent after trauma. Actual demonstration of enhancement within the affected renal artery (renal artery cutoff sign) was observed in one of 10 cases in our series and in two of eight previously reported cases [6–10]. When present, it indicates an occluded renal artery, particularly in association with contrast medium extravasation. However, a false-positive diagnosis may occur when an enhanced renal artery abruptly terminates on a CT section because it passes out of the CT section. Retroperitoneal hematoma with renal displacement occurred in nine of 10 cases in our series and in four of eight previously reported cases. Despite their frequent occurrence, they are nonspecific and do not specify a renal vascular injury.

We conclude that CT can be used reliably to diagnose posttraumatic occlusion of the main renal artery or a major segmental branch and that angiography is not necessary in most cases to confirm the diagnosis. The most useful CT sign is absence of a nephrogram in the involved kidney or segment. Absence of a pyelogram on CT is a useful sign with main renal artery occlusions but not with segmental artery injuries. Other reported CT signs are helpful but not consistently present.

REFERENCES