Complications of Renal Transplantation: What Every Radiologist Should Know

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Learning objectives

The purpose of this exhibit is to:

1. Review the clinical background of renal transplantation.
2. Discuss the utility of ultrasound as first-line imaging modality for evaluation of renal transplantation in the early postoperative period and in the long-term surveillance.
3. Review the ultrasonographic findings of renal transplant complications that every radiologist should know.

Background

Renal transplantation is the treatment of choice of endstage renal disease (ESRD). Marked improvements in early graft survival and longterm graft function have been achieved due to advancements in surgical techniques, effective immunosppression, human leukocyte antigen (HLA) typing for donor-recipient matching, transplant coordinating networks and in ability to diagnose and treat complications of renal transplantation.

In the United States alone, over 381,739 kidney transplants have been performed from January 1, 1988 to September 10, 2015. According to the 2012 Organ Procurement and Transplantation Network (OPTN)/Scientific Registry of Transplant Recipients (SRTR) 2012 Annual Data Report, about 190.000 patients were alive and with a functioning transplanted kidney; and currently, there are more than 120.000 patients are waiting for kidney transplants. Henceforth, there is an pressing demand for intense monitoring and imaging studies to help ensure a successful outcome.

In this clinical setting, ultrasonography is often the firstline imaging technique in early evaluation of renal transplantation in the postoperative period and longterm followup.

Findings and procedure details

We reviewed the ultrasonographic findings of renal transplantation complications, including graft dysfunction, vascular and urologic complications and fluid collections, as described below:
**Functional Complications**

- Biopsy is required to differentiate acute tubular necrosis from rejection and drug toxicity;
- Acute and chronic rejection are the most frequent causes of graft loss;
- **Triplex Ultrasound findings:**
  - nonspecific;
  - elevated RI in the intrarenal arteries (#0,8);
  - may have altered parenchymal echogenicity and thickness.
  - **Contrast-enhanced sonography (CES) with injected agitated microbubbles:**
    - Significantly longer inflow time of the contrast medium to the cortex and renal pyramids in patients with acute rejection than in recipients with ATN.

**Vascular complications**

**Main causes:** technical problems at the anastomosis, perivascular fibrosis, rejection, compression from a peri-transplant fluid collection.

1) **Renal artery stenosis**

- 75% of all vascular complications;
- Usually diagnosed within the first year after surgery;
- Up to half of cases occur at the site of the arterial anastomosis;
- **Ultrasonographic findings (Fig 1):**
  - Focal area of color aliasing;
  - Increased flow velocity (PSV # 250 cm/sec);
  - Velocity gradient between the stenotic and prestenotic (iliac vessel) segments > 2:1;
  - stenotic renal artery PSV 13 times higher than that of an interlobar artery;
  - Distal tardus parvus waveform.

2) **Arterial thrombosis**
• Rare complication;
• Occurs in the early post-transplant period, usually within the first month after surgery;
• Major cause of early graft loss;
• Ultrasonographic findings:

- segmental infarction (Fig 2 and 3):
  - hypoechoic region or mass, poorly marginated or with an echogenic wall (differential diagnosis with severe pyelonephritis or transplant rupture);
  - wedge shaped area without color flow;
- global infarction (main artery affected) (Fig 4 and 5):
  - hypoechoic and heterogeneous diffusey enlarged graft;
  - absence of color flow (arterial and venous) in both main and inter-lobar vessels distal to occlusion;
    • CES with injected agitated microbubbles: higher sensitivity and specificity in the detection of infarction.

3) Renal vein thrombosis

• Usually occurs in the first postoperative week;
• Ultrasonographic findings (Fig 6, 7 and 8):

- Enlarged kidney;
- Reduced or absent venous flow;
- Increased resistance arterial flow, including reversal of diastolic flow.

4) Renal vein stenosis

• Ultrasonographic findings (Fig 9, 10 and 11):

- focal area of color aliasing at the stenotic segment due to increased velocity flow (3-4-fold increase in the maximum velocity between the stenotic and prestenotic segments).

5) Arteriovenous fistula

• Intraparenchymal, postbiopsy complication;
• Diferencial diagnosis with intrarenal arterial stenosis;
• Ultrasonographic findings (Fig 12):

- Color mosaic pattern isolated to a single segmental or interlobar artery and its paired vein.
- Feeding artery shows high velocity and low resistance turbulent flow;
- Draining vein demonstrates arterialization.

6) Pseudoaneurysm

• Intraparenchymal, postbiopsy complication;
• Extrarenal, at the vascular anastomosis, caused by surgical technique or infection;
• Risk of infection and rupture;
• Ultrasonographic findings (Fig 13 and 14):

- Simple or complex cyst on gray-scale images;
- To-and-fro spectral Doppler flow pattern.

Urologic complications

1) Urinary obstruction

• Occurs in approximately 2% of transplantations
• Usually in the first 6 months after transplantation
• More than 90% of within the distal third of the ureter
• Caused by scarring secondary to ischemia or rejection, by technical complication during ureteroneocystostomy, or by kinking. These events account for more than 50% of obstruction stricture.
• Less common causes include pelvic fibrosis, calculi, papillary necrosis, fungus ball, clots, and compression from an extrinsic mass such as adjacent peritransplant collections.
• Ultrasonographic findings (Fig 15):

- Hydronephrosis

2) Urine leaks and Urinoma

• Urine leaks and urinomas are relatively rare complications.
• Leakage of urine may occur from the renal pelvis, ureter, or ureteroneocystostomy site due to ureteral necrosis caused by vascular insufficiency or increased urinary pressures caused by obstruction.
• Caliceal extravasation is an uncommon cause and occurs secondary to segmental infarction in patients with accessory renal arteries or due to ligation of a polar artery.
• Usually in the first two postoperative weeks after surgery

Ultrasonographic findings (Fig 16 and 17):

- anechoic and well defined collection
- usually between the renal graft and the bladder

Peritransplant fluid collections

- Reported in up to 50% of renal transplantations
- Include urinomas, hematomas, lymphoceles, and abscesses.
- Clinical significance is determined by size, location and possible growth
- In the immediate postoperative period, small hematomas or seromas appear as crescentic peritransplant collections
- When sufficiently large may cause complications related to mass effect on the transplant:
  - hydronephrosis,
  - kinking of the vascular pedicle (which can lead to stenosis, thrombosis)
  - compromised parenchymal perfusion
- other
  • Hematoma and urinoma develops immediately postoperative period
  • Lymphocele occur 4-8 weeks after the surgical procedure.
  • Diagnosis may be made only with percutaneous aspiration.

1) Hematoma

- Usually small and resolve spontaneously.
- Other causes: trauma, post biopsy
- Ultrasonographic findings (Fig 18):

  - Nonspecific
- Acute hematomas: echogenic and become less echogenic with time. Older hematomas: anechoic, more closely resembling fluid, and septations may develop.

2) Lymphocele
The most common peritransplant fluid collection
- Prevalence of 0.5%-20%.
- May develop at any time
- Usually an early complication, occurring within 1-2 months after transplantation.
- Caused by leakage of lymph from surgically disrupted lymphatic channels along the iliac vessels or from the lymphatics of the transplanted kidney.
- Lymphoceles are the most common fluid collection that causes transplant hydronephrosis.
- **Ultrasonographic findings**
  - anechoic collection that may have internal septations

3) Abscess

- More than 80% of renal transplant recipients suffer at least one case of infection during the first year after transplantation.
- Caused by pyelonephritis or arise from a previously sterile collection
- **Ultrasonographic findings**:
  - Complex, cystic, nonspecific appearance at US.

**Images for this section:**
Fig. 1: Case 1: Spectral Doppler ultrasound showing stenosis of the arterial anastomosis.

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Fig. 2: Case 2: B mode ultrasound showing a segmental infarction (hypoechoic region poorly marginated).

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Fig. 3: Case 3: Power Doppler Ultrasound showing a polar renal infarction.

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**Fig. 4:** Case 4: Doppler ultrasound showing main renal artery thrombosis, determining absence of arterial and venous color flow in both main and inter-lobar vessels distal to occlusion.

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Fig. 5: Case 4: Reformatted CT scan of the same patient, sagital view of a contrasted phase, showing a perfused native kidney (white circle) and the transplanted kidney without perfusion (blue circle) due to main renal artery thrombosis.

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Fig. 6: Case 5: Color Doppler Ultrasound showing absent of flow at the renal venous vascular bed, due to thrombosis of the main renal vein.

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Fig. 7: Case 5: Triplex ultrasound showing intrarenal reverse diastolic flow secondary to thrombosis of the main renal vein.

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Fig. 8: Case 5: Reformatted CT scan of the same patient, sagital view of the precontrast phase, showing spontaneous hyperattenuation of the main renal vein secondary to thrombosis (blue arrow).

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Fig. 9: Case 6: Venous anastomosis stenosis - Color Doppler ultrasound showing reduced intrarenal venous flow.

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**Fig. 10:** Case 6: Venous anastomosis stenosis - Spectral Doppler showing increased velocity flow in the stenotic segment (venous anastomosis).

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Fig. 11: Case 6: Venous anastomosis stenosis - low velocity flow at the post-stenotic venous segment.

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Fig. 12: Case 7: Triplex ultrasound showing an arteriovenous fistula after renal biopsy.

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**Fig. 13:** Case 8: B mode ultrasound (right) and Doppler ultrasound (left) showing an extrarenal pseudoaneurysm.

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**Fig. 14:** Case 8: Doppler ultrasound showing an extrarenal pseudoaneurysm.

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**Fig. 15:** Case 9: B Mode US of renal transplant shows an echogenic foci with sharp posterior acoustic shadowing at the proximal ureter (ureteral calculus), as indicated by the arrow, causing hydroureteronephrosis.

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Fig. 16: Case 10: B mode ultrasound showing an urinoma.

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Fig. 17: Case 10: Reformatted CT cystography of the same patient showing the urinoma (U) and the urine leak (curve yellow arrow) near to the vesicoureteral anastomosis (blue arrows).

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**Fig. 18:** Case 11: B mode ultrasound showing a postbiopsy perirenal hematoma.

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Conclusion

Knowledge of renal transplantation complications as depicted on the first-line imaging modality - ultrasound - is important to ensure an accurate diagnosis and prompt treatment.

Personal information

References


