Interventional Nephrology Primer: Part 3

Native and Transplant Kidney Biopsy

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Native Kidney Biopsy

Percutaneous kidney biopsy is an invasive procedure that is performed when kidney tissue is required to make a definitive diagnosis, provide information about disease progression or prognosis.

Indications for kidney biopsy

Indications	Comments
Hematuria	Presence of acanthocytes or red blood cell casts with an elevated Scr level or proteinuria
Proteinuria	Proteinuria > 1 g/d as measured on multiple visits with no clear comorbidity; proteinuria > 3 g/d in the absence of diabetes or a rapid increase in proteinuria even with diabetes; proteinuria < 3 g/d with an elevated Scr level with no clear comorbid conditions such as diabetes or hypertension
AKI	In the setting of ATI, persistent injury despite reversal of cause or if Scr did not return to baseline with 7-14 d of injury onset; in the setting of presumptive AIN, if there has been no resolution of injury despite removal of culprit medication
CKD	Rapid elevation in Scr level or new-onset hematuria or proteinuria

Abbreviations: AIN, acute interstitial nephritis; AKI, acute kidney injury; ATI, acute tubular injury; CKD, chronic kidney disease; Scr, serum creatinine.

Complications of kidney biopsy

Complication	Comment
Bleeding	Most common complication
Hematoma (75%)	Develop in a high percentage of patients; visualize active extravasation at biopsy site with ultrasonography
Subcapsular bleed (<1%)	Significant bleeding may lead to subcapsular accumulation and resistant HTN (Page kidney)
Retroperitoneal bleed (5%-10%)	Complication of persistent bleeding or disruption of clot over biopsy site; image with CT or ultrasonography and follow up
Microscopic (>90%) or gross (40%-50%) hematuria	Persistence may lead to clot formation in kidney or bladder resulting in obstruction and hydronephrosis
Lumbar vessel laceration (<1%)	Requires a selective angiogram to identify the bleeding vessel
AVF formation (<5%)	Benign and can be followed up; should be intervened upon if it results in persistent bleeding, resistant HTN, high-output HF, or AKI
Pain (30%-50%)	May radiate into inguinal region or periumbilical region; will usually subside and should be treated with acetaminophen; if persistent, should result in re-imaging the kidney
Infection (<5%)	Low risk, but risk is worsened with skin infection, pyelonephritis, bleeding, or poor sterile technique
Nephrectomy (<1%)	Incidence is very low and with IR procedures, not common
Death (<1%)	Incidence is very low and is worsened by bleeding risk

Abbreviations: AKI, acute kidney injury; AVF, arteriovenous fistula; CT, computed topography; HF, heart failure; HTN, hypertension; IR, interventional radiology.

Contraindications for kidney biopsy

Contraindication	Comment
Bleeding risk	Increased bleeding risk with platelet count < 120 × 10^3/μL, elevated INR, and use of anticoagulation including aspirin, warfarin, heparin, and direct factor Xa inhibitors
Anticoagulation concerns	Higher risks would exist in patients in whom stopping anticoagulation therapy would pose significant medical risk (mechanical valve, active VTE disease, high $CHADS_2$ score, LVAD, active APLS)
Hypertension	If systolic BP > 140 mm Hg, BP should be lowered before proceeding
Small hyperechoic kidneys	Indicative of chronic disease and should be avoided if eGFR is < 30 mL/min/1.73 m^2
Anatomical kidney problems	Vascularity of kidney anomalies or multiple cysts increase bleeding risk
Horseshoe kidney	Preferred route is transjugular biopsy
Multiple bilateral cysts	If cysts are numerous, it may be difficult to visualize areas that are cyst free
Hydronephrosis	Biopsy should be delayed until the obstruction is relieved and only pursued if injury persists despite adequate time
Solitary kidney	If the kidney is visible and biopsy is safe, there is no increased risk with a solitary kidney performed by an experienced provider
Infection	Skin infection over the site of needle insertion can lead to sepsis; ongoing pyelonephritis could worsen infection and lead to sepsis
Altered mental status	If the patient cannot cooperate with the biopsy, the risk for injury may be too significant

Abbreviations and definitions: APLS, antiphospholipid syndrome; BP, blood pressure; $CHADS_2$, congestive heart failure, hypertension, age (≥65 years = 1 point, ≥75 years = 2 points), diabetes, and stroke/transient ischemic attack (2 points); eGFR, estimated glomerular filtration rate; INR, international normalized ratio; LVAD, left ventricular assist device; VTE, venothromboembolic.

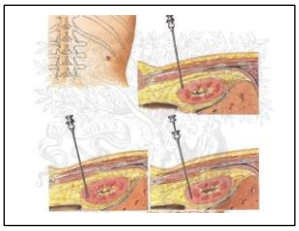
Management of antithrombotic agents in kidney biopsy

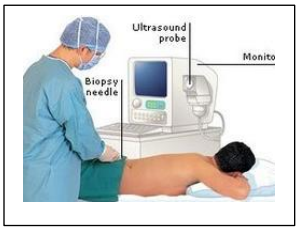
Aspirin	High risk for CV event Low risk for CV event	Continue aspirin (2C) Stop 7–10 d before procedure (2C)
Vitamin K antagonists (*e.g.*, warfarin)	High risk for thromboembolism Low risk for thromboembolism	Use bridging anticoagulation (2C) Stop 5 d before procedure (1C); resume 12–24 h after procedure (2C)
Intravenous UFH as bridging anticoagulation	High risk for thromboembolism	Stop 4–6 h before procedure (2C)
LMWH as bridging anticoagulation	High risk for thromboembolism	Last therapeutic dose 24 h before procedure; for procedures at high risk of bleeding, resume 48–72 h after procedure (2C)

CV, cardiovascular; 2C, weak recommendation on the basis of low-quality evidence; 1C, strong recommendation on the basis of low-quality evidence; UFH, unfractionated heparin; LMWH, low molecular weight heparin. Modified from ref. 49, with permission.

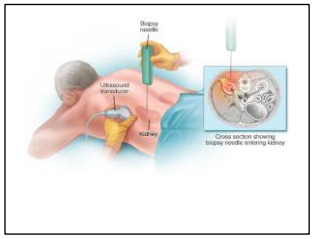
Kidney biopsy Procedure

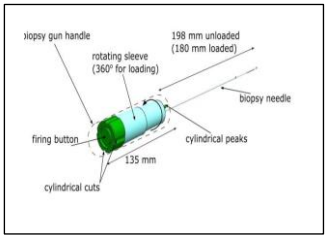
1. Prone Position of the Patient

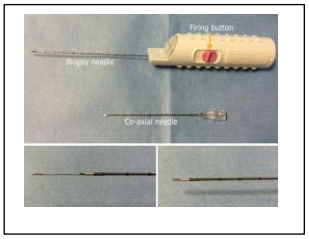


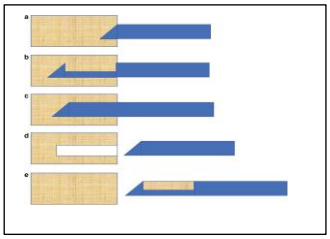


2. Kidney Biopsy Gun: 10-20 cm length, 16-18 Gauge

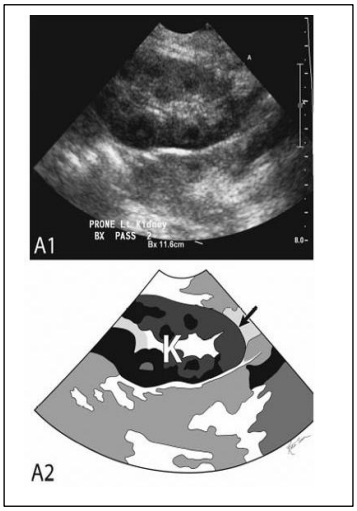


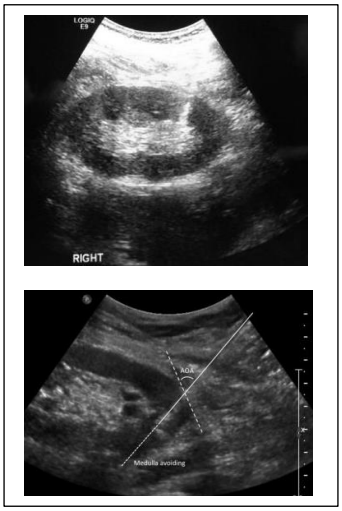




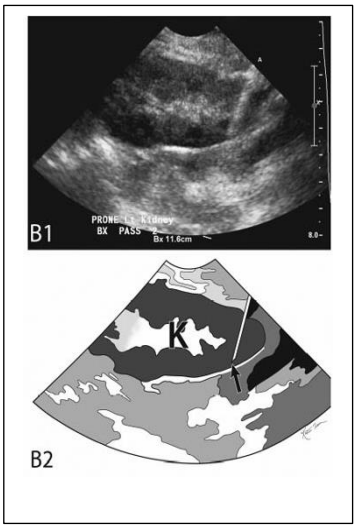


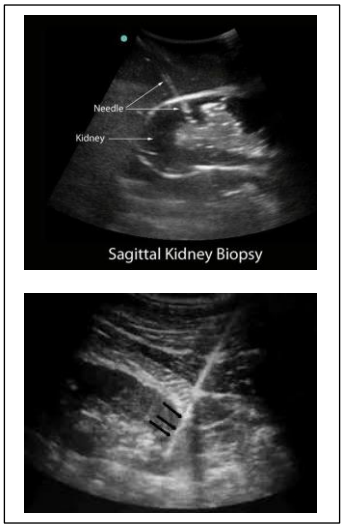
3. Visualizing the kidney using the ultrasound

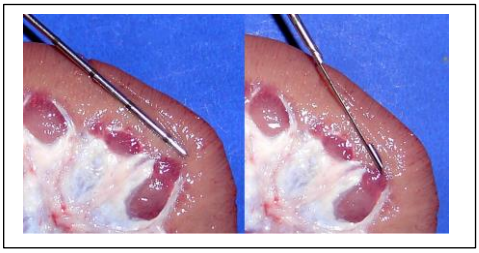




4. The needle is fired within the kidney

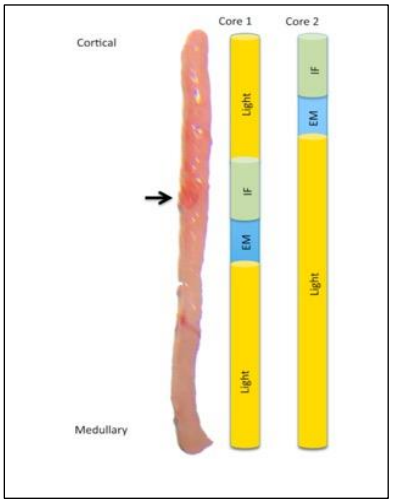






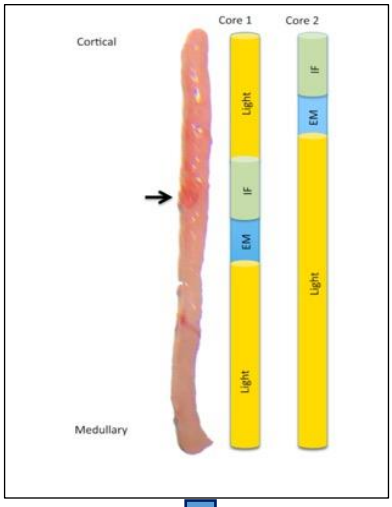
5. Dividing Kidney Sample at Pathology Laboratory

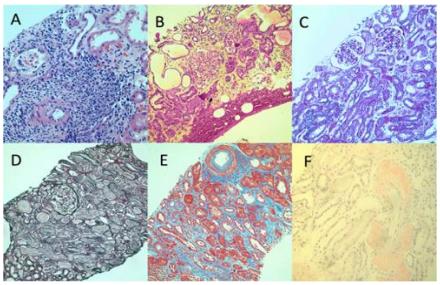
Renal biopsy specimens as seen with a dissecting microscope. Black arrows point to glomeruli (wet prep, ×10).



Kidney biopsy core, with cortical and medullary sides indicated. Arrow points to glomeruli tuft. The core should be divided into samples for light, immunofluorescence (IF), and electron microscopy (EM). Samples should be divided in a way to ensure cortical tissue in each solution to maximize the presence of glomeruli.

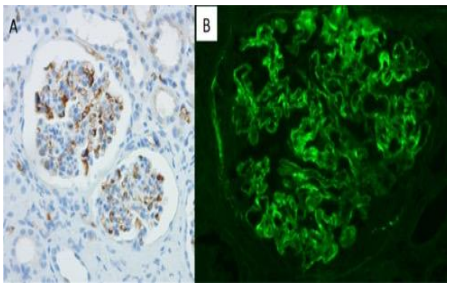
Pathologic Examination in the Pathology Laboratory



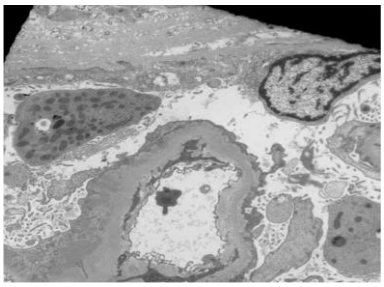


Light microscopy of kidney biopsy

(A) Hematoxylin-eosin stain (×100). Nuclei will stain deep purple and cytoplasm pink. (B) Hematoxylin phloxine saffron stain (×100). Areas of fibrous tissue will stain yellow-orange. (C) Periodic acid–Schiff stain (×100). Polysaccharides in basement membranes will stain deep purple. (D) Jones stain (×100). (E) Trichrome stain (×40). This stains cytoplasm as red and collagen as blue. (F) Congo red stain (×200). Amyloid fibrils are stained red in the vessel and interstitium.

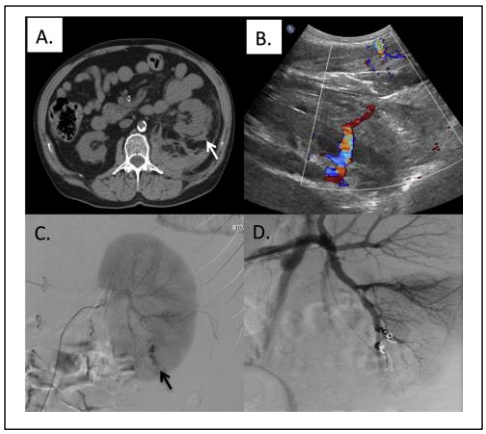


Immunohistochemistry (IHC) and immunofluorescence microscopy of kidney biopsy specimens. (A) Detection of immunoglobulin A using IHC; immune complexes appear as brownish material in the mesangium. (B) Detection of C3 using immunofluorescence (original magnification, ×400).

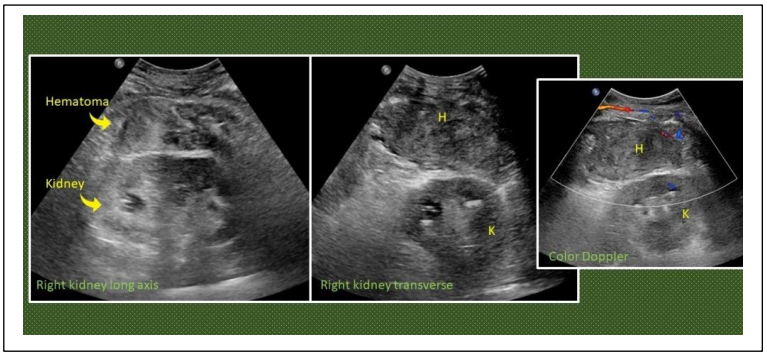


Electron microscopy of a capillary loop (original magnification, ×4,000). Dense deposits in the basement membrane appear as darkened areas within the membrane.

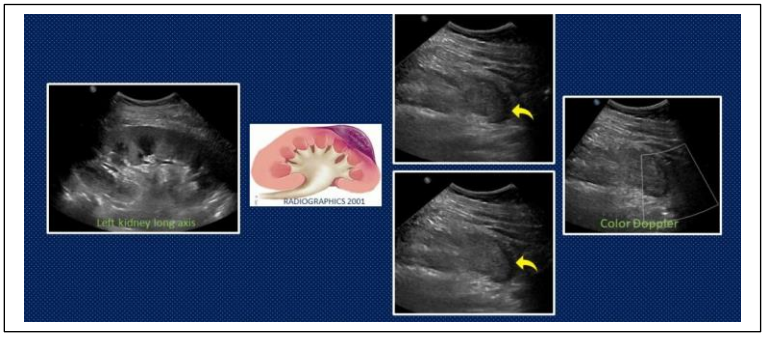
Hemorrhagic Complications of Kidney Biopsy



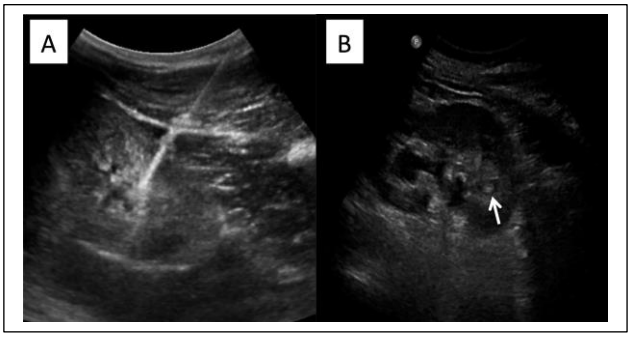
Bleeding as a complication of kidney biopsy. (A) Computed tomographic image with arrow pointing to a hematoma with resulting retroperitoneal hemorrhage. (B) Doppler ultrasound shows active extravasation of blood after biopsy. (C) Fluoroscopy shows active extravasation of contrast from a site of persistent bleeding. (D) Coiling of a vessel that was actively bleeding in panel C.



Large perinephric hematoma



Small subcapsular hematoma



Urinary outlet obstruction caused by bleeding after kidney biopsy. (A) Ultrasound image of a biopsy shows core being obtained in left lower pole. (B) Image 5 days after biopsy when patient reported inability to void. Ultrasound demonstrates hydronephrosis and clot (white arrow) within kidney

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Transplant Kidney Biopsy

Ultrasound-guided percutaneous transplant kidney biopsy (renal allograft) is performed mainly for investigating the cause of kidney transplant dysfunction and monitoring the status of normally functioning kidney transplants (protocol biopsy).

The goal of kidney transplant biopsy is to obtain cortical tissue that has sufficient glomeruli and muscular arteries for pathologic evaluation.

The most common approach is the cortical tangential method in which the needle path parallels the outer capsule of the kidney reaching the edge of the medullary pyramids. In most cases, biopsy of the lateral cortex is most utilized in right lower quadrant (Figure 1: solid white line; Figure 2). Alternatively, the posterolateral aspect of the transplant kidney cortex can be used (Figure 1: dashed line). Occasionally, the anterior cortex of the transplant can be targeted (Figure 1: dotted line; Figure 3).

When the typical transverse approach is used to biopsy the allograft, the needle is inserted lateral to the surgical scar of the transplant surgery (Figure 4).


Figure 1

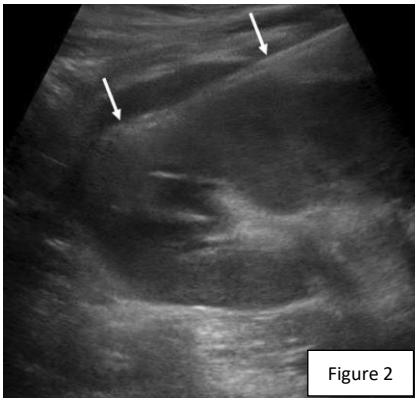
Figure 2

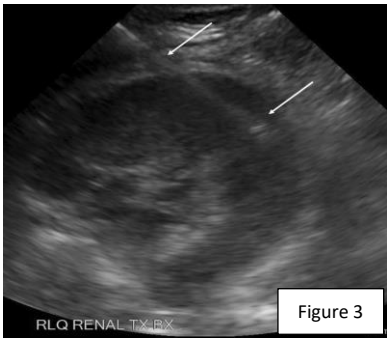

Figure 3

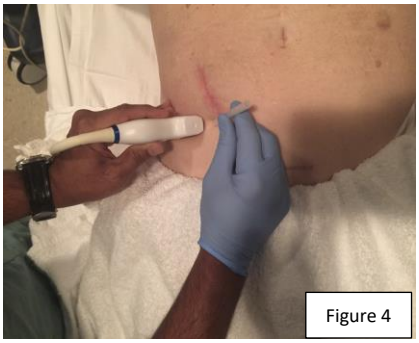
Figure 4

Types of transplant kidney biopsy devices are shown in Figure 1 (Ref 1).

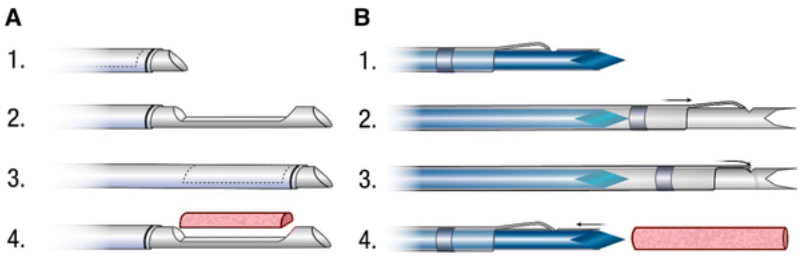

Figure 1: A. Traditional side-notch biopsy device captures a semi-cylindrical core of tissue. B. End-fire biopsy device captures a complete cylinder of tissue (Ref 1).

Complications of transplant kidney Biopsy:

1. Intrarenal arteriovenous fistula.
2. Small perinephric hematomas.
3. Hematuria.
4. Bleeding.

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