Kidney Biopsy: A Comprehensive Student Guide

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KIDNEY BIOPSY: CT-GUIDED NATIVE KIDNEY BIOPSY

PA/Medical Student Handout

LEARNING OBJECTIVES

By the end of this module, you will be able to:

1. **Understand the indications** for native kidney biopsy
2. **Explain the anatomy** of why the left kidney is preferred
3. **Describe the procedure** step-by-step, including equipment and technique
4. **Identify complications** and their frequency/management
5. **Interpret specimen adequacy** requirements
6. **Counsel patients** on risks, benefits, and realistic expectations
7. **Recognize contraindications** and patient selection criteria

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SECTION 1: CLINICAL INDICATIONS

When to Biopsy a Kidney

Kidney biopsy is essential for diagnosing glomerular diseases when:

Indication	Why Biopsy?
Nephrotic syndrome	Distinguish causes: FSGS, membranoproliferative GN, membranous, minimal change
Nephritic syndrome	Define type of glomerulonephritis (IgA vs. ANCA vs. anti-GBM)
Acute kidney injury	Distinguish prerenal from intrinsic renal causes; identify RPGN
Rapidly progressive GN	Determine if ANCA, anti-GBM, or immune complex ☐ guides immunotherapy
Systemic diseases with renal involvement	Characterize renal pathology in lupus, vasculitis, amyloidosis

Indication	Why Biopsy?
CKD of unclear etiology	Identify specific pathology when diagnosis uncertain
Persistent asymptomatic hematuria/proteinuria	Rule out significant GN

When NOT to Biopsy

- **Uncontrolled hypertension** (ABSOLUTE contraindication; >160/100 increases bleeding risk)
- **Active coagulopathy or on anticoagulation** (must correct first)
- **Bleeding disorder** (platelet <50k, INR >1.5)
- **Solitary kidney** (relative; consult with nephrology)
- **Kidney size <9cm** (increased bleeding risk)
- **Multiple bilateral cysts** (technical difficulty)
- **Unwilling/unable patient** (requires informed consent)

SECTION 2: ANATOMY AND KIDNEY SELECTION

Why Left Kidney?

The **left kidney is PREFERRED** for several anatomical reasons:

Advantage	Explanation
Lower position	Sits slightly lower due to liver on right ☐ more accessible
Posterior relationship to colon	Clearer window; reduced bowel perforation risk
Predictable anatomy	Less vascular variability than right
Retroperitoneal exposure	Better for CT guidance

Renal Position and Anatomy

- **Right kidney**: Tucked under liver; smaller, more caudal approach
- **Left kidney**: Sits lower, lateral to spine, posterior to peritoneum
- **Both kidneys**: Retroperitoneal (NOT intraperitoneal)
- **Normal size**: 10-12 cm in length; ideally >9cm for safe biopsy

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SECTION 3: PROCEDURE OVERVIEW

Pre-Procedure Preparation

Patient Education: - Explain: Biopsy is the ONLY way to definitively diagnose kidney disease - Risk of bleeding (microscopic hematuria common, gross hematuria 3-10%) - Small risk of AV

fistula (10-20%, mostly asymptomatic) - Discuss alternatives if available (less common for native kidney biopsies) - Obtain informed consent

Laboratory Work: - CBC (platelet count; Hgb/Hct baseline) - PT/INR and PTT (coagulation studies) - Type & cross (rarely needed, but have blood available) - Renal function (creatinine, eGFR) - Urinalysis (baseline)

Pre-Procedure Instructions: - NPO 4-6 hours before procedure - Hold anticoagulation (warfarin 3-5 days; heparin 24 hours before; aspirin individualized) - Reassess coagulation after holding anticoagulation - IV access × 2

SECTION 4: THE BIOPSY PROCEDURE

Equipment Setup

CT Imaging: - Non-contrast CT to localize left kidney - Identify inferior pole position (preferred biopsy site) - Measure **skin-to-kidney distance** (typically 7-10 cm) - Mark entry point with CT laser; use Sharpie pen

Biopence Needle System: - **16-gauge needle** (optimal: balances tissue yield vs. bleeding risk) - **20 cm length** (accommodates various body habitus) - **Spring-loaded mechanism** with adjustable throw depth (15-23 mm) - **Half-cock position** allows depth adjustment at the bedside

Step-by-Step Procedure

Step 1: Patient Positioning - Prone position on CT table - Pillow under abdomen (elevates kidney) - Encourage relaxed, deep breathing

Step 2: CT Localization - Scout images, then thin-section CT (2-3 mm slices) - Identify inferior pole of left kidney - Calculate skin-to-capsule distance - Add 2-3 mm for needle advancement into cortex - Mark entry point; use laser for lateral alignment

Step 3: Anesthesia - Cleanse skin with antiseptic (Betadine or chlorhexidine) - Infiltrate 1-2% lidocaine into skin and deeper tissues - Create finder needle tract with spinal needle along planned path - Wait 5-10 minutes for anesthesia to work

Step 4: Biopsy Technique - Half-cock the Biopence gun; set depth selector (typically 20-22 mm) - Make small 2-3 mm skin nick with blade - Position needle tip at kidney capsule under CT guidance - Patient takes deep breath, holds at inspiration - Fire needle smoothly at end-inspiration - Kidney moves 2-3 cm with respiration—time biopsy to match CT planning phase

Step 5: Specimen Collection - Immediately place tissue core on Telfa pad (non-adherent) - Use sterile 4×4 gauze field - Never touch specimen directly; handle only with Telfa pad - Place pad in sterile specimen cup - Deliver to pathology IMMEDIATELY (some stains require fresh tissue)

Step 6: Obtain Adequate Samples - Aim for **2-3 cores minimum** - Each core 1-2 cm length - Should contain **≥10 glomeruli** for adequate diagnosis - Preserved tissue architecture critical for pathology interpretation

Step 7: Post-Procedure Care - Apply pressure to puncture site (5-10 minutes) - Position patient supine with sandbag on biopsy site - Monitor vital signs every 15 minutes × 2 hours, then hourly

- Strict bedrest (most complications occur within 4 hours) - Monitor urine output; report gross hematuria - Check Hgb/Hct before discharge - Discharge after 4-6 hours if stable

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SECTION 5: SPECIMEN HANDLING

Critical Points for Pathology

Specimen Placement: - **Cortical tissue**: Contains glomeruli needed for diagnosis - **Medullary tissue**: Less useful; indicates inadequate cortical sampling - **Length assessment**: Each core should be 1-2 cm (adequate for multiple sections)

Processing Requirements: | Study | Container | Timing | |——-|———|———| | **Light microscopy** | Formalin-fixed (standard) | Within hours | | **Immunofluorescence** | FRESH tissue in saline | IMMEDIATELY (minutes) | | **Electron microscopy** | Fixed glutaraldehyde | IMMEDIATELY |

Red Flags for Inadequate Specimen: - Cores <5mm in length - No visible glomeruli on low-power magnification - Predominantly medullary tissue - Torn or fragmented architecture

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SECTION 6: COMPLICATIONS AND MANAGEMENT

Frequency and Characteristics

Complication	Frequency	Characteristics	Management
Gross hematuria	3-10%	Blood in urine; self-limiting	Hydration; monitor; reassure
Retroperitoneal hematoma	1.7-11%	Detected on imaging; may be asymptomatic	Most resolve spontaneously
Clinically significant bleed	<1-2%	Requires intervention (IR or transfusion)	Usually managed conservatively
AV fistula formation	10-20%	Mostly asymptomatic; found on imaging	Serial ultrasound; angioembolization if symptomatic
Blood transfusion needed	0.4-2%	Rare; depends on pre-existing factors	Associated with anticoagulation or bleeding disorder
Infection	<0.5%	Rare with proper technique	Antibiotics; monitor for sepsis
Nephrectomy	<0.02%	Catastrophic; life-threatening bleed	AVOID with proper patient selection/technique
Mortality	<0.02-0.1%	Extremely rare; usually from delayed recognition	Proper patient selection; monitoring

Signs Requiring Urgent Evaluation

☐ **CALL FOR HELP IF**: - Expanding flank mass (suggests active bleeding) - Persistent hypotension despite fluids - Macroscopic hematuria lasting >48 hours - Signs of sepsis/infection - Severe persistent back/flank pain

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SECTION 7: UNDERSTANDING AV FISTULAS

What's an AV Fistula?

An **arteriovenous fistula** is an abnormal communication between renal artery and renal vein created during biopsy.

Key Facts: - Occurs in 10-20% of biopsies (modern ultrasound detects more than previously thought) - **Vast majority (>95%) asymptomatic** and require no treatment - Detected incidentally on follow-up ultrasound - Usually small, low-flow, self-limited

When Does an AV Fistula Matter?

Symptomatic fistulas develop IF: - Large size or high flow - Causing high-output cardiac stress - Associated with resistant hypertension - Causing continued macroscopic hematuria

Management Options: 1. **Observation** (most common; 95% of cases) 2. **Serial ultrasound** monitoring every 6-12 months 3. **Angiographic embolization** (coiling) if symptomatic 4. **Surgical repair** (rarely needed; embolization preferred)

SECTION 8: PATHOLOGY REPORTING

Understanding the Report

Standard Biopsy Report Includes:

Element	What It Tells You
Number of glomeruli	Adequacy of sample (need ≥10)
Glomerular morphology	Proliferative, membranous, sclerotic, crescentic, etc.
Light microscopy findings	Overall pattern diagnosis
Immunofluorescence pattern	Immune complex vs. pauci-immune
Electron microscopy	Ultrastructural details (deposits, GBM thickness)
Tubulointerstitial changes	Fibrosis, atrophy (prognostic)
Vascular changes	Arteriosclerosis, hypertensive changes

Interpretation Example

Lupus Nephritis (Class IV): - Light: Proliferative GN with crescent - IF: Granular IgG, IgA, IgM, C3, C1q (full house pattern) - EM: Electron-dense deposits in subendothelial space - Treatment: Intensive immunosuppression (mycophenolate, tacrolimus ± steroids)

IgA Nephropathy: - Light: Minimal to proliferative - IF: **IgA dominant** (IgA ≥ other immunoglobulins) - EM: Electron-dense deposits in glomerular mesangium - Treatment: ACE-I/ARB; consider SGLT2i; steroids for progressive disease

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SECTION 9: PATIENT COUNSELING

Before the Procedure

"Your kidney biopsy is a small procedure that lets us see exactly what's happening inside your kidney. A doctor will use an ultrasound machine to guide a thin needle and take a small sample of kidney tissue—just a couple of millimeters. It takes about 5 minutes. Afterward, you'll rest for a few hours and go home.

Most people have some blood in their urine afterward, which is normal and goes away in 1-2 days. Serious bleeding is rare (less than 1%), and about 1 in 5 people might develop a tiny connection between an artery and vein in the kidney, but this almost never causes problems.

We cannot diagnose your kidney disease without this test, so it's the most important step in getting you the right treatment."

After the Procedure

"You did great! Here's what to expect: - **Blood in urine**: Normal for 1-2 days; drink plenty of water - **Bed rest**: Stay home today and rest tomorrow - **No heavy lifting**: For 1 week - **Activity**: Gradually increase as you feel better - **Watch for**: Expanding lump in your flank, severe pain, fever, or persistent heavy bleeding ☐ call immediately

Your biopsy results will be ready in 3-5 days. We'll discuss what they mean and your treatment plan at your follow-up appointment."

SECTION 10: KEY CLINICAL PEARLS

☐ **Left kidney is preferred** for easier access and lower complication rates

☐ **Kidney must be >9cm** to minimize bleeding risk

☐ **Absolute contraindication**: Uncontrolled hypertension (>160/100 mmHg)

☐ **CT guidance superior to ultrasound** for accuracy and complication reduction

☐ **Most complications occur within 4 hours**—close monitoring essential

☐ **AV fistula is common (10-20%) but asymptomatic in >95%** of cases

☐ **Fresh tissue to pathology IMMEDIATELY** for immunofluorescence (some fluorophores degrade quickly)

☐ **Adequate specimen** = ≥10 glomeruli per core (2-3 cores minimum)

☐ **Bleeding risk increases with**: Anticoagulation, thrombocytopenia, bleeding disorder, advanced age, diabetes

☐ **Specimen handling is critical**—never allow tissue to dry or freeze before processing

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PRACTICE QUESTIONS

Question 1: A 28-year-old woman with nephrotic syndrome (3.5 g proteinuria/day) needs a kidney biopsy. Labs show: Plt 180k, INR 1.1, creatinine 0.8 mg/dL, albumin 2.1 g/dL. BP 158/96 mmHg. What is the MOST important next step?

A) Proceed with biopsy today
B) Control blood pressure first, then biopsy
C) Wait for albumin to normalize (>2.5) before biopsy
D) Administer fresh frozen plasma

Answer: **B** - This patient has **uncontrolled hypertension (158/96)**, which is a **relative contraindication** to kidney biopsy due to increased bleeding risk. Blood pressure should be controlled to <140/90 mmHg before proceeding. The other labs are acceptable (normal platelets, INR, creatinine). Waiting for albumin normalization is not necessary—biopsy can proceed with moderate hypoalbuminemia.

Question 2: During a kidney biopsy, 2 tissue cores are obtained. The pathologist reports: "2 cores, each 1.5 cm, total 22 glomeruli, excellent preservation." What does this finding indicate?

A) Specimen is inadequate; need to repeat
B) Specimen is adequate; diagnosis can be made
C) Specimen is excellent; high-quality diagnosis possible
D) Cannot assess adequacy without immunofluorescence results

Answer: **C** - This is an **excellent specimen**. The criteria for adequacy are: - ☐ ≥10 glomeruli per core (11-12 per core here) - ☐ Core length 1-2 cm (achieved) - ☐ Multiple cores (2 cores = good representation) - ☐ Preserved tissue architecture With 22 total glomeruli and good core size, diagnosis can be made with high confidence. Repeat biopsy NOT needed.

Question 3: A patient develops macroscopic hematuria 30 minutes after kidney biopsy. Vitals: BP 128/82, HR 88, Hgb 13.5 g/dL. What is the BEST management?

A) Emergent CT angiography
B) Immediate coil embolization
C) Strict bedrest, NPO, serial Hgb monitoring
D) Discharge with follow-up

Answer: **C** - **Macroscopic hematuria within hours of biopsy is expected and usually self-limited**. The patient is hemodynamically stable with normal hemoglobin. Management is: - Keep NPO (in case surgery needed) - Strict bedrest - Monitor Hgb q4-6 hours (expect gradual fall only if significant bleeding) - Encourage hydration (IV fluids) - Continue observation - Only escalate if: persistent hypotension, dropping Hgb, or macroscopic hematuria >48 hours

Emergent imaging/intervention only if patient becomes unstable or hematuria persists >48 hours.

KEY TAKEAWAYS

☐ **Kidney biopsy is DIAGNOSTIC** for determining specific glomerular disease

☐ **CT-guided approach** provides superior accuracy and safety vs. ultrasound

☐ **Left kidney preferred** for anatomy and lower complication rates

☐ **Most complications minor** (gross hematuria self-limited, AV fistula asymptomatic)

☐ **Uncontrolled hypertension is CONTRAINDICATION**—must control BP first

☐ **Proper coagulation** status essential; correct thrombocytopenia, INR before biopsy

☐ **Specimen adequacy** = ≥10 glomeruli; requires 2-3 adequate cores

☐ **Fresh tissue to pathology immediately** for complete diagnostic workup

☐ **Post-procedure monitoring** = first 4-6 hours critical for complication detection

☐ **Patient counseling** about risks vs. benefits essential; inform consent required

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RELATED CLINICAL NOTES

See Also

Related Student Handouts

- Nephritic and Nephrotic Syndromes
- Lupus Nephritis
- IgA Nephropathy
- Vasculitis and Complement-Mediated Diseases
- Glomerular Treatment Principles
- Renal Labs and Imaging

Clinical Content (01-Clinical-Medicine/Nephrology)

- Glomerular Diseases Hub
- Procedures and Diagnostics Index
- Essential Renal Laboratory Tests

Butler-COM Resources

- Butler COM - Nephrology Deep Dive

- Pathology and Classification
- Clinical Presentation and Workup
- RPGN Diagnosis and Urgent Treatment
- Most Common Primary GN Worldwide

- Classification and Treatment

This handout is designed for PA/medical student education. Always consult current clinical protocols and pathology guidelines for biopsy interpretation.