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DIAGNOSTIC YIELD AND COMPLICATION RATE FOLLOWING PERCUTANEOUS RENAL BIOPSY

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Abstract

Objective: *To evaluate the diagnostic adequacy, safety, and complication rates of ultrasound-guided percutaneous renal biopsies performed with an 18-gauge automated biopsy needle in both native and transplanted kidneys.*

Study Design: *Prospective Longitudinal Study.*

Study Setting: *Department of Interventional Radiology, Shifa International Hospital, Islamabad, Pakistan.*

Study Duration: *November 2024 to April 2025.*

Methodology: *A total of 186 ultrasound-guided percutaneous renal biopsies (143 native, 43 transplant) were performed using an 18-gauge automated needle. Standardized protocols were followed for patient selection, pre-procedure preparation, the biopsy procedure itself, and post-procedural monitoring. Tissue adequacy and complications were recorded and analyzed.*

Results: *The mean patient age was 37.9 ± 16.7 years, with 62.9% being male. The mean number of glomeruli per biopsy was 12.9, exceeding the minimum required for diagnosis. Tissue adequacy was achieved in 100% of cases. The overall complication rate was low, with minor complications (e.g., small hematoma) observed in 13% of patients and a major complication rate of only 0.53%. No patient required blood transfusion, angiographic embolization, or nephrectomy. Complications were significantly more common in native kidney biopsies compared to transplant biopsies (23.1% vs. 0%, $p < 0.001$).*

Conclusion: *Ultrasound-guided percutaneous renal biopsy using an 18-gauge automated needle is a safe and highly effective diagnostic procedure. When performed by skilled operators with appropriate patient selection, it yields sufficient tissue for diagnosis with a very low incidence of complications for both native and transplant kidneys.*

INTRODUCTION

Renal biopsy is a cornerstone diagnostic procedure in nephrology, offering definitive histological diagnoses for a broad spectrum of renal diseases in both native and transplanted kidneys. Since its introduction in the 1950s, the technique has evolved substantially. Image-guided percutaneous biopsy is now considered the gold standard due to improved safety and diagnostic yield. [1]

Renal biopsies are essential in evaluating glomerular disorders, interstitial nephritis, systemic conditions such as lupus nephritis or vasculitis, and unexplained renal dysfunction. In transplant

recipients, biopsies aid in detecting rejection, infection, and recurrence of disease. [2]

Common indications include nephrotic and nephritic syndromes, persistent proteinuria or haematuria, acute kidney injury of unknown cause, and surveillance of allograft function. [3,4] Appropriate patient selection guided by laboratory workup and imaging is critical to reduce procedural risks. Contraindications include uncontrolled hypertension, coagulopathies, and anatomical abnormalities like solitary or fibrotic kidneys. [4]

An adequate renal biopsy sample typically requires at least 5–10 glomeruli to allow accurate histopathological interpretation. [1] Technological advances, such as automated spring-loaded biopsy devices and real-time ultrasound guidance, have enhanced both safety and diagnostic yield. [5–7]

The 18G needle is widely accepted as providing an optimal balance between tissue adequacy and safety, with lower bleeding risk than larger-gauge needles. [8] Operator expertise, targeting the lower pole, and rigorous post-procedural protocols further minimize complication rates. [6, 9]

This study evaluates the diagnostic yield and safety profile of ultrasound-guided percutaneous renal biopsies at a tertiary care centre, with the aim of informing local practice and contributing to broader clinical knowledge.

METHODOLOGY:

This prospective longitudinal study was conducted at Shifa International Hospital, Islamabad, Pakistan, following approval from the Institutional Review Board (IRB# 527-24; October 30, 2024). The study aimed to include all consecutive ultrasound-guided, non-targeted percutaneous renal biopsies performed between October 30, 2024, and April 30, 2025. The sample size was calculated based on an anticipated complication rate of 13% from prior literature, resulting in a target of 174 patients. Allowing for a 5% attrition rate, the final sample was adjusted to 183, and a total of 186 patients were ultimately enrolled.

The study included both native and transplant kidney biopsies. Inclusion criteria mandated a platelet count >50,000/mm³ (>100,000/mm³ for suspected lupus nephritis) and an International Normalized Ratio (INR) <1.5, with informed consent being obligatory. Patients were excluded if they were undergoing targeted renal mass biopsies, procedures under general anesthesia (e.g., pediatric or uncooperative patients), CT-guided or trans-jugular biopsies, or had an active upper urinary tract infection. For patients with risk factors such as bleeding disorders, anemia (hemoglobin <7 g/dL), uncontrolled hypertension, advanced age, obesity, or use of anticoagulant medication, a separate high-risk consent was obtained after detailed discussion of potential complications, including major bleeding requiring intervention.

A standardized protocol was followed for all procedures. Patients were admitted to a day-care facility and fasted for at least four hours pre-procedure. Pre-biopsy workup included a complete blood count, coagulation profile, and renal imaging. Anticoagulants were withheld as per guidelines, and inquiries were made regarding the use of homeopathic medications with anticoagulant properties. Uncontrolled hypertension (systolic >140 mmHg or diastolic >80 mmHg) was corrected by the referring team before the biopsy. Pre-procedure intravenous analgesia (1g Paracetamol) and sedation (0.5–2 mg Midazolam) were administered to reduce anxiety and kidney movement.

With the patient in a prone position, interventional radiologists used ultrasound to identify the biopsy site, preferentially targeting the lower pole of the kidney to avoid major hilar vessels. After sterile preparation and local anesthesia with 2% xylocaine, a small skin incision was made. Under continuous ultrasound guidance, two cores of renal cortex were obtained using an 18-gauge automated biopsy needle. A third pass was performed only if a pathologist deemed the initial samples inadequate upon immediate assessment. All ultrasound images were archived in the hospital's PACS.

Post-biopsy monitoring involved applying firm pressure and performing serial ultrasound examinations immediately, after five minutes, and at one hour. If a hematoma was identified, its baseline volume was documented and monitored with scans every 15–20 minutes alongside vital sign checks. Patients were prescribed six hours of strict bed rest with regular vital monitoring. Chest X-rays

were reserved only for patients with respiratory symptoms or low oxygen saturation. Asymptomatic and stable patients were discharged after six hours. Management of complications, such as significant hematomas or vital instability, included intravenous fluids, analgesics, contrast-enhanced CT scans, and, if necessary, blood transfusion or angiographic embolization.

Data were analyzed using SPSS version 26, with continuous variables reported as mean ± standard deviation and categorical variables as frequencies and percentages. Fisher's exact test was used for group comparisons, with a p-value < 0.05 considered statistically significant.

RESULTS:

A total of 186 patients underwent ultrasound-guided percutaneous renal biopsy during the study period from October 30, 2024, to April 30, 2025. The cohort included 117 males (62.9%) and 69 females (37.1%), with ages ranging from 7 to 77 years (mean ± SD: 37.86 ± 16.74 years). Among these, 143 (76.9%) were native kidney biopsies and 43 (23.1%) were transplant kidney biopsies.

All biopsies were performed using an 18-gauge automated biopsy needle (Monopty or Maxcore-Bard), under real-time ultrasound guidance. The majority of patients (93%) underwent two biopsy passes, while 5.4% required a third pass due to initial sample inadequacy. In two high-risk patients (1.1%), only a single core was obtained after consultation with the nephrology team.

The average glomerular yield per biopsy was 12.9 glomeruli (range 1–37), exceeding the minimal adequacy threshold (5–10 glomeruli) for reliable histopathological diagnosis. All specimens were processed for light microscopy, immunofluorescence, and electron microscopy. Adequacy was confirmed immediately in all cases during the procedure, with only 10 biopsies necessitating an additional third core.

Post-procedure complication rates were low. No complications were observed in 160 patients (86%). Minor complications, defined as small perinephric hematomas or mild haematuria without clinical significance, were identified in 25 patients (13%). One patient (0.53%) developed a major complication in the form of a perinephric hematoma measuring approximately 100 ml on 1-hour post-biopsy ultrasound; this patient was admitted for overnight observation and managed conservatively without need for intervention such as embolization or transfusion.

No patient required blood transfusion, angiographic embolization, nephrectomy, or experienced procedure-related mortality during the study period. There was no documented occurrence of arteriovenous fistula or pseudoaneurysm.

The distribution of complications differed significantly between native and transplant biopsies. Among native kidney biopsies, 33 patients (23.1%) experienced minor complications, whereas no complications were observed in transplant biopsies ($p < 0.001$, Fisher's exact test).

Table 3 shows the final renal biopsy histopathology results. The most common diagnosis was Focal Segmental Glomerulosclerosis (FSGS), observed in 29 patients (16.1%), and followed by Diabetic Nephropathy in 27 patients (15.1%) and IgA Nephropathy in 25 patients (14.0%). Lupus Nephritis was diagnosed in 17 patients (9.7%), while Antibody-Mediated Rejection was seen in 10 patients (5.4%) and T-cell Mediated Rejection in nine patients. Both Membranous Glomerulonephritis (MGN) and Membranoproliferative Glomerulonephritis (MPGN) were found in six patients each (3.2%). C1q Nephropathy was identified in 5 patients (2.7%), and Chronic Antibody-Mediated Rejection in four patients (2.2%).

TABLE 1: CLINICAL AND DEMOGRAPHIC CHARACTERISTICS OF THE STUDY POPULATION

Characteristic	Value
Total number of patients	186
Age (mean ± SD)	37.86 ± 16.74 years
Sex	
• Male	117 (62.9%)
• Female	69 (37.1%)
Biopsy Needle Type	Automated 18G (100%)
Biopsy Type	
• Native Kidney	143 (76.9%)
• Transplant Kidney	43 (23.1%)
Needle Gauge	18G (100%)
Number of Passes	
• One	2 (1.1%)
• Two	173 (93%)
• Three	10 (5.4%)
Average Glomeruli per Biopsy	12.9
Tissue Adequacy	186/186 (100%) adequate
Extra Core Requested due to Inadequacy	10 (5.4%)

TABLE 2: COMPLICATIONS AMONG NATIVE AND TRANSPLANT KIDNEY BIOPSIES

Complication Type	Native (n = 143)	Transplant (n = 43)	Total (n=186)	p-value
No Complications	110 (76.9%)	43 (100%)	153 (82.3%)	< 0.001
Minor Complications	33 (23.1%)	0	33 (17.7%)	< 0.001

TABLE 3: FINAL RENAL BIOPSY HISTOPATHOLOGY RESULTS

Diagnosis	Frequency	Percentage (%)
Focal Segmental Glomerulosclerosis (FSGS)	29	15.6%
Diabetic Nephropathy	27	14.5%
IgA Nephropathy	25	13.4%
Lupus Nephritis	17	9.1%
Antibody-Mediated Rejection	10	5.4%
T-cell Mediated Rejection	9	4.8%
Membranous Glomerulonephritis (MGN)	6	3.2%
Membranoproliferative GN (MPGN)	6	3.2%
C1q Nephropathy	5	2.7%
Chronic Antibody-Mediated Rejection	4	2.2%
Minimal Change Disease	3	1.6%
ANCA GN and Vasculitis	3	1.6%
Advanced Glomerulosclerosis	3	1.6%
MPGN with IgA	3	1.6%
IgM Nephropathy	3	1.6%

C3 GN with IgA Nephropathy	3	1.6%
C1q Deposits	2	1.1%
Pauci-Immune Crescentic GN	2	1.1%
Non-specific deposits	2	1.1%
Total	186	100%

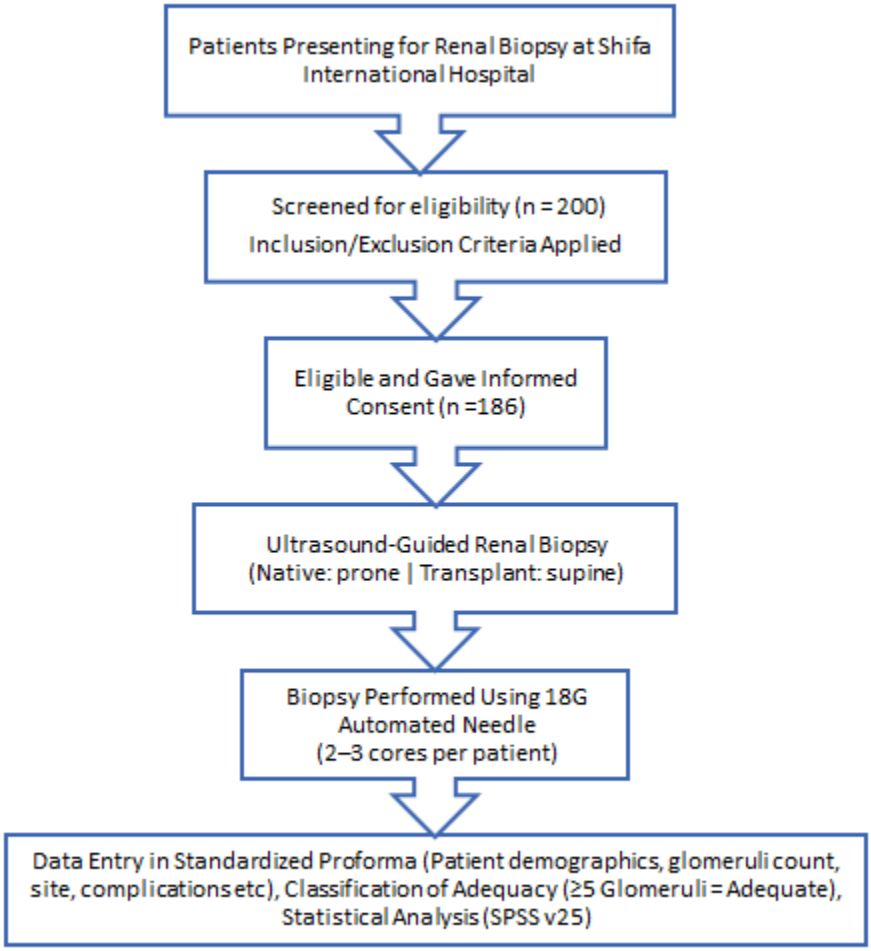

FIGURE-1: PATIENT FLOW DIAGRAM

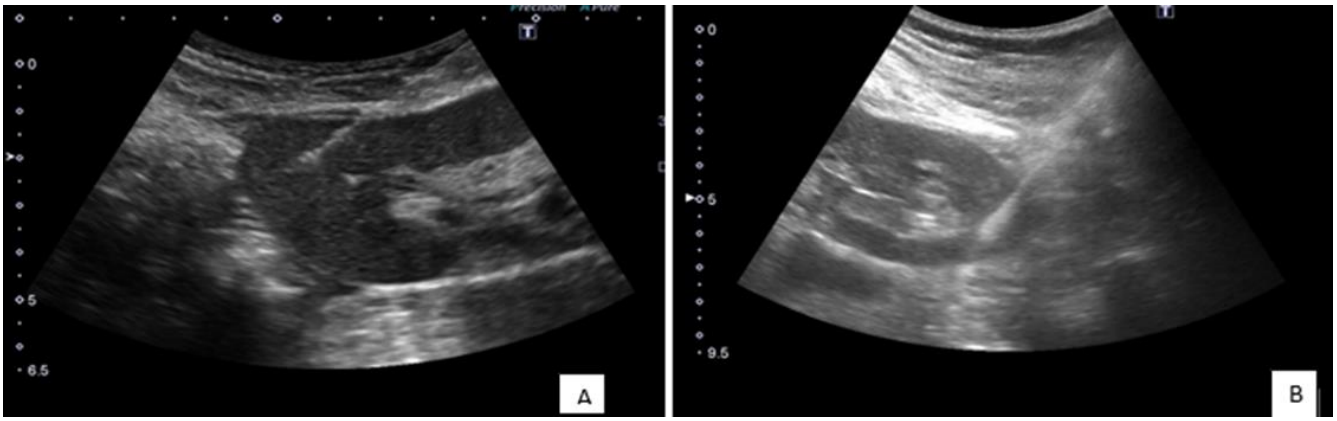

Figure-2. Transplant and native renal biopsy. (A) Transplant kidney ultrasound (longitudinal view) with biopsy needle in upper pole cortex via caudo-cranial approach. (B) Native kidney ultrasound (longitudinal view) with biopsy needle in lower pole cortex

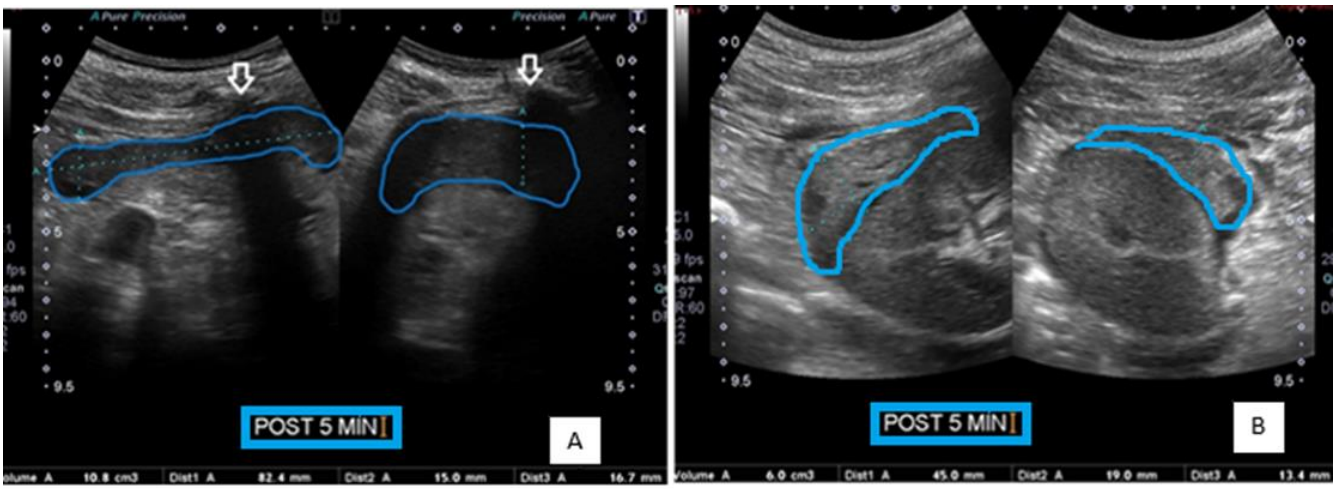

Figure-3. (A) Native kidney ultrasound with small hypoechoic hematoma (10ml) near upper pole cortex. (B). Native kidney ultrasound with isoechoic peri-nephric hematoma (6ml). Arrow points out the rib shadow.

DISCUSSION:

The findings of this study confirm that ultrasound-guided percutaneous renal biopsy using an 18G automated needle is both diagnostically effective and safe. The average glomerular yield of 12.9 glomeruli per biopsy exceeded the recommended minimum for diagnostic adequacy. Only a small proportion of patients 10 (5.4%) required a third biopsy pass. [10]

Minor complications occurred in 17.7% of cases, with no major adverse events. These results are consistent with previous studies reporting low complication rates and adequate tissue sampling using 18G needles under ultrasound guidance. [11, 12] Qadri et al. found similar glomerular yields and complication profiles, emphasizing the balance between safety and tissue adequacy with 18G needles. [13] Bhattacharya et al. also reported minor complication rates between 10–15%, supporting the safety of this approach. [14] Table 1 shows clinical and demographic characteristics of the study population.

The absence of arteriovenous fistula or pseudoaneurysm supports findings from other studies suggesting that real-time ultrasound guidance and operator experience significantly reduce such risks. [15] The rigorous pre-biopsy screening and adherence to coagulation thresholds likely contributed to the favorable safety outcomes. [16]

Complications were more common in native kidney biopsies, likely due to anatomical differences, variable cortical thickness, and parenchymal heterogeneity. Prior studies have similarly suggested that targeting the lower pole in native kidneys may reduce bleeding risk. [17, 18]

The most frequent histopathological diagnosis in our study was Focal Segmental Glomerulosclerosis (FSGS), accounting for 15.6% of cases, followed by diabetic nephropathy (14.5%) and IgA nephropathy (13.4%). These findings are consistent with previously published data from various centers in Pakistan. At the Sindh Institute of Urology and Transplantation (SIUT), Karachi, FSGS was reported as the most common primary glomerulonephritis (29%) in a large series of 1793 biopsies. [19] Similarly, a study from Bahawal Victoria Hospital, Bahawalpur found FSGS to be the leading diagnosis (28.2%) among 195 adult patients. [20] In contrast, some regional differences have been noted. A study conducted at the Chughtai Institute of Pathology in Lahore identified membranous glomerulonephritis (MGN) as the most prevalent lesion (30.6%), followed by FSGS (28%). [21] At KRL Hospital, Islamabad, MGN also ranked highest (38.8%), with FSGS comprising 16.4%. [22] Meanwhile, data from Pakistan Institute of Medical Sciences (PIMS), Islamabad demonstrated IgA nephropathy as the most common primary glomerular disease (16%), followed by MGN (15.4%) and MPGN (13.6%). [23] These variations in disease spectrum may reflect differences in biopsy indications, referral patterns, ethnicity, and environmental exposures across different regions in Pakistan. However, the predominance of FSGS, MGN, and IgA nephropathy across most reports highlights their central role in the burden of glomerular disease in the Pakistani population. [24, 25]

While this study provides valuable insights, certain limitations should be acknowledged. Its single-center design, a modest sample size, short post-procedural follow-up. The study also lacked direct comparisons with other needle sizes or procedural techniques, and minor complications may have been underreported due to reliance on clinical documentation.

CONCLUSION:

Ultrasound-guided percutaneous renal biopsy using an 18G automated needle is a reliable and safe diagnostic modality for both native and transplant kidneys. High tissue adequacy and minimal complication rates emphasize the importance of operator experience, standardized protocols, and careful patient selection. These findings support continued use and refinement of this technique in both high- and moderate-resource settings.

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