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Indications for Percutaneous Ultrasound-Guided Renal Biopsy and Complications Associated with it: An Observational Study

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Abstract

Renal biopsy is performed for various reasons depending on the clinical manifestations presented. Although percutaneous kidney biopsy is a safe procedure, major or minor complications could occur. Our study aimed to assess the indications for percutaneous renal biopsy and complications associated with the procedure. This was a prospective observational study conducted in the Department of Nephrology, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, India. Patients who underwent percutaneous ultrasound-guided renal biopsy at the institute between October 2017 and June 2019 were enrolled in the study. Data regarding indications for performing a percutaneous renal biopsy and incidence of minor and major post-biopsy complications were collected. A total of 229 patients who underwent ultrasound-guided percutaneous renal biopsy were enrolled in the study. The most common indications for ultrasound-guided percutaneous renal biopsy were nephrotic syndrome (33.3%), subnephrotic proteinuria with azotemia (14%), and unexplained azotemia with proteinuria and hematuria (13.5%). Post-biopsy complications were observed in 89 (37.55%) patients. Minor complications developed in 83 (36.22%) patients and major complications in six (2.62%) patients. Among patients with major complications, two (0.87%) patients underwent invasive procedures (embolization and cystoscopic removal of bladder clot) and four patients developed hemodynamic instability. No procedure-related mortality was reported in the study. The most common indications for renal biopsy were nephrotic syndrome, subnephrotic proteinuria with azotemia, unexplained azotemia with proteinuria, and hematuria. The incidence of major complications was low.

Keywords: azotemia; complications; nephrotic syndrome, percutaneous ultrasound-guided renal biopsy; renal biopsy

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Introduction

An ultrasound-guided percutaneous renal biopsy is an important tool in nephrology practice to confirm diagnosis, recommend therapy, determine treatment outcome, and establish the degree of active and chronic changes.[1,2] Percutaneous renal biopsy provides valuable information for the prognosis and management of patients. Renal biopsy has advanced with the addition of tools and technology that optimize the result. The real-time ultrasonography to localize the kidney

and automated biopsy needles have improved considerably the safety of both procedure and its numbers considerably.[3–6]

For the ultrasound-guided percutaneous renal biopsy to be successful, adequate pre-procedure evaluation of patient, preparation for the procedure, and post-procedure monitoring are essential. The indications for performing a renal biopsy are determined by the presented clinical manifestations. Although ultrasound-guided percutaneous kidney biopsy is a safe procedure, minor or major complications could occur.[1] Some studies have reported significant complications in less than 1% of patients;[7,8] contrarily, some studies have reported higher rates of complications.[9–11]

We conducted this single-center observational study to assess the indications for ultrasound-guided percutaneous renal biopsy and to find out the rate of complications associated with it. We evaluated whether the number of minor and major complications is comparable to that reported in the literature.

Methods and Materials

Patients

This was a prospective, single-center observational study conducted at the Department of Nephrology, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, India. The inclusion criterion was patients who underwent percutaneous ultrasound-guided renal biopsy at the Institute between October 2017 and June 2019. Exclusion criteria were prothrombin time-International Normalized Ratio (PT-INR) > 1.3, platelet count < 50,000/cu mm, uncontrolled hypertension (systolic BP > 160 mmHg and diastolic BP > 90 mmHg), or acute exacerbations of chronic obstructive pulmonary disease (COPD), chronic liver disease, congestive heart failure, stroke, solitary kidney (native), or usage of antiplatelet drug (aspirin, clopidogrel, etc.) within 7 days of biopsy. Additionally, patients with hydronephrosis, cyst, perinephric abscess, and small-size kidneys (<9 cm proven by ultrasound) were also excluded.

Biopsy procedure

All biopsies were performed under real-time ultrasound guidance (Esoate MyLab™ Six Mode ultrasound system No. 164XX NL 192108) under local anesthesia (1–2% lignocaine) injected from the skin down to the renal capsule, along the biopsy tract. One pediatric patient required sedation. The biopsies were performed with an automated biopsy gun (Bard® TruGuide® model No. MC1816) with a 16-gauge needle for adults and an 18-gauge needle for pediatric patients.

In order to perform biopsy, the patients were placed in prone position. Renal biopsies were performed preferentially from the left kidney, as it is away from the major vessels. The skin was prepped with povidone–iodine and draped to maintain sterility. The USG probe was covered with a sterile cover and placed on the skin after applying sterile jelly.

Before reaching the renal capsule, the patient was instructed to take a deep inspiration and hold it so that the lower pole came under the needle tip. The needle was advanced to pass the capsule and then triggered to collect specimen. Then the needle was withdrawn immediately, and the patient was instructed to start breathing. We collected two cores of kidney tissue—one core was transferred in a vial containing normal saline for immunofluorescence examination, and the other core was transferred in a vial containing 10% formalin for light microscopic examination. The specimens were examined within 24 h of collection. An immediate post-biopsy ultrasound was performed to inspect perinephric hematoma.

Post-biopsy observations

During post-biopsy period, all patients were kept on 8-h bed rest and observed for 24 h at the hospital. Patients were advised not to perform any strenuous activity for 2 weeks after discharge from the hospital. Patients were monitored for post-biopsy complications. The post-biopsy complications were categorized as minor and major complications. Minor complications included complications that did not require surgical intervention and/or blood transfusion. Major complications included complications that required surgical intervention and/or blood transfusion.

Statistical analysis

Statistical Package for Social Sciences (SPSS), version 21, was used for data analysis. The data were first keyed in MS Excel 2007 then converted into SPSS for analysis. The results were expressed as proportions or mean ± SD. Pearson's Chi-squared and Fischer's Exact *t*-test were used for comparison of proportions and percentage values. A two-tailed $P < 0.05$ was considered statistically significant.

Result

The study enrolled 229 of the 261 patients who underwent renal biopsy at the institute. A total of 32 patients were excluded, as they did not satisfy the inclusion/exclusion criteria. Of the 229 patients, 136 were males and 93 were females. The mean age of the patients was 39.86 ± 15.22 years.

The most frequent indications for renal biopsy were nephrotic syndrome (76; 33.2%), subnephrotic proteinuria with azotemia (32; 14%), unexplained azotemia, proteinuria, and hematuria (31; 13.5%; Table 1).

The most commonly observed post-percutaneous renal biopsy complications were pain (89; 38.86%), hematoma

(13; 5.67%), gross hematuria (11; 4.8%), and hypotension (5; 2.2%; Table 2). A statistically significant relation between hematoma and azotemia (P = 0.03) was observed (Table 3). No statistically significant relationship was recorded between frequency of complications and age groups or hypertension (Tables 4 and 5). The gross hematuria was resolved within 24 h post-biopsy in eight of the 11 (3.49%) patients without any hemodynamic instability.

Most patients had a mean change of <1 and ≥1–<2 mg/dL in hemoglobin from baseline to post-biopsy (57.6% and 24.5%, respectively; Table 6). However, no substantial difference was observed in the overall change in the mean value of hemoglobin from baseline to post-biopsy. The mean change of ≥2 mg/dL in hemoglobin from baseline to post-biopsy was observed in 13 (5.7%) patients.

In all, 6 (2.62%) patients developed major complications, and 2 of the 6 (0.87%) patients underwent an invasive procedure (Table 7). Three (1.31%) patients with gross hematuria developed major complications—pseudoaneurysm with persistent hematuria, urinary bladder clot, and persistent hematuria 30 h post-biopsy. The patient who developed pseudoaneurysm with persistent hematuria for 3 days, complicated by hypotension, required angiographic localization of bleed with embolization and 3 units of blood transfusion for hemodynamic instability. The patient who developed clot in the urinary bladder after hematuria with retention of urine required cystoscopy to remove clot. The third patient with persistent hematuria for 30 h post-biopsy with hypotension also required blood transfusion.

Three of the five patients with hypotension required blood transfusion. One of these three patients had pseudoaneurysm, requiring embolization of the feeder artery, and two patients required intravenous normal saline. No procedure-related mortality was recorded in our study.

Table 1: Reasons for ultrasound-guided percutaneous renal biopsy.

Indications	n (%)
Nephrotic syndrome	76 (33.2)
Asymptotic urinary abnormalities	72 (31.5)
Subnephrotic proteinuria with azotemia	32 (14.0)
Subnephrotic proteinuria	22 (9.6)
Subnephrotic proteinuria with hematuria	18 (7.9)
Unexplained azotemia and rapidly progressive renal failure	49 (21.4)
Unexplained azotemia	13 (5.7)
Unexplained azotemia with hematuria	5 (2.2)
Unexplained azotemia with proteinuria and hematuria	31 (13.5)
Systemic disease	14 (6.1)
Acute kidney injury	11 (4.8)
Post-renal transplant azotemia	7 (3.1)

Discussion

Renal biopsy is an important decision-making tool in nephrology practice. Although percutaneous renal biopsy is a safe procedure, minor or major complications could take place. Various factors are associated with the occurrence of complications during and post-biopsy. This prospective single-center study aimed to assess indications for percutaneous ultrasound-guided renal biopsy and associated post-biopsy complications.

Table 2: Complications of percutaneous renal biopsy.

Complication	n (%)
Pain	89 (38.86)
Hematoma	13 (5.67)
Gross hematuria	11 (4.80)
Hypotension	5 (2.20)
Urinary bladder clot	4 (1.75)
Urinary retention	1 (0.44)
Need for blood transfusion	3 (1.31)
Pseudoaneurysm	1 (0.44)

Table 3: Post-biopsy complications and relation with azotemia.

Creatinine (mg/dL)	Pain	Hematoma	Hematuria	Hypotension	Blood transfusion	Urine retention
>1.3	43	11	9	3	3	1
≤1.3	46	2	2	1	0	0
P-value	0.19	0.03	0.12	0.63	0.26	0.32

Table 4: Frequency of complications in different age groups.

	Pain (no analgesia)	Pain (with analgesia)	Gross hematuria	Hematoma	Hypotension	Blood transfusion	Bladder clot	Urine retention
≤15	1	3	2	0	0	0	1	0
16–30	14	11	3	2	2	2	1	0
31–45	16	13	4	5	1	0	1	1
46–60	13	8	1	6	1	0	0	0
>60	6	5	1	0	1	1	1	0
P-value	0.84		0.25	0.183	0.83	0.19	0.26	0.7

Table 5: Frequency of complications and hypertension.

Hypertension	Pain (no analgesia)	Pain (analgesia)	Gross hematuria	Hematoma	Hypotension	Blood transfusion	Bladder clot	Urine retention
Yes	26	19	5	5	3	2	3	1
No	24	21	6	8	2	1	1	0
P-value	0.7		0.64	0.49	1.0	1.0	0.62	1.0

Table 6: Change in hemoglobin level.

Change in hemoglobin level (mg/dL)	n (%)
<1	132 (57.64%)
≥1 and <2	56 (24.45%)
≥2	13 (5.67%)
Unchanged	28 (12.22%)

Table 7. Major complications developed during the study.

Complications	n
Pseudoaneurysm with persistent hematuria	1
Urinary bladder clot	1
Persistent hematuria 30 h post-biopsy	1
Hypotension requiring blood transfusion	3

We observed that the most common indications for percutaneous renal biopsy were nephrotic syndrome (33.2%), subnephrotic proteinuria with azotemia (14%) unexplained azotemia, and proteinuria with hematuria (13.5%). These results were consistent with the studies reporting indications and epidemiologic data of renal biopsies in India.[12–15] The percentage of patients with other indications was consistent with that observed in some other studies.[16,17]

We observed a lower risk of major complications (2.6%). Similar to our results, a prospective study also reported that percutaneous renal biopsy was associated with a 5% risk of major complications.[18] Although the risk of major complications in our study was much lower, it can be due to the comparatively smaller sample size (229 in our study vs. 5304 patients). However, unlike the results of our study, the researchers reported that a decrease in hemoglobin level of ≥2 mg/dL was the most frequently observed post-biopsy complication. Furthermore, they reported that higher plasma creatinine levels, liver disease, and higher number of needle passes were the risk factors for major complications.[18]

In our study, pain was the most commonly reported post-biopsy complication (38.86%) whereas hematoma occurred in 5.67% of patients, and of these 2.2% of patients developed a major complication. The observed rate of hematoma was within the range reported by other studies (4–33% of patients).[19,20] Also, the percentage of patients with hematoma developing major complications was similar to results of cited studies that reported major complications in 1.9% of patients with hematoma.

Hematoma can be subcapsular, retroperitoneal, or, rarely, due to injury of the lumbar vessels. The post-procedural ultrasound investigation is important to capture the hematoma. The hematoma usually leads to minor or major post-procedure developments. Hence, it is considered a

predictor of bleeding-related complications; however, no significant relationship has been found between the size of hematoma and the extent of bleeding.[21–23] It can be asymptomatic or associated with hematuria, flank pain, anemia, or shock.

Hematuria is a very common complication of percutaneous biopsy. Microscopic hematuria occurs in almost all patients whereas gross hematuria occurs in 5–9% patients.[22] Hematuriacan increase due to uncontrolled hypertension or uremia. Hematuria usually resolves spontaneously within 2 days, but in approximately 0.5% patients, it may persist for 2–3 weeks. Sometimes, gross hematuria is observed in patients a few days after the biopsy, which resolves with rest.[22] We observed gross hematuria in 11 (4.8%) patients, and 3 (1.31%) of these developed major complications. Our results are also consistent with a study conducted among 750 patients, in which hematuria was reported in 35 (4.6%) patients, and 12 (1.6%) of these patients required blood transfusion or invasive procedure.[20]

Percutaneous renal biopsy is sometimes associated with severe complications. Hence, pre-procedure evaluation of patients to avoid complications is imperative.[6,24] The pre-procedure evaluation must include the history of bleeding diathesis, recent use of nonsteroidal anti-inflammatory drugs (NSAID), control over hypertension, recent pyelonephritis or skin infections near the biopsy site, and the ability to comply with instructions during the biopsy.[25] The complete blood count, platelets, and PT/INR are evaluated prior to procedure on a routine basis. Although bleeding time has no significant correlation to surgical bleeding,[26] biopsy complications are mainly related to bleeding. Moreover, Stiles et al. performed renal biopsies without evaluating bleeding time, and demonstrated that the bleeding time does not significantly alter the rates of major complications.[27] The post-renal bleeding complications are typically related to the blood vessels of the perinephric area or the collecting system and rarely to the lumbar or mesenteric artery.[19]

Manno et al. prospectively evaluated the predictive value of demographics, clinical data, baseline chemistry, and needle size for the risk of post-renal biopsy complications in 471 patients.[19] They concluded that only gender, age, and baseline partial thromboplastin time (PTT) showed a significant predictive value but the other variables investigated did not have any predictive value. Although we did not evaluate the predictive value of these factors, we did not observe any significant statistical relations between the frequency of complications and age groups or pre-existing hypertension.

A study performed percutaneous renal biopsies in 394 native kidneys and concluded that observation of patients for 23–24 h is optimal, but observation for 8 h or lesser period is unsafe for missing approximately 20% of complications.[28] Contrarily, the literature review shows that 3% of complications occur within 8 h and that 91% occur within 24 h of procedure.[29] We observed patients for 24 h post-biopsy. Biopsy-related infections are rare; and no infections were observed in our study.[30]

Conclusion

Ultrasound-guided renal needle biopsy is an essential tool in nephrological practice. It is imperative in the diagnosis and therapeutic management of patients. It is a highly standardized invasive procedure associated with a high technical success rate and a relatively small number of minor or major complications. The most common indications for renal biopsy were nephrotic syndrome, subnephrotic proteinuria with azotemia, unexplained azotemia with proteinuria and hematuria, and subnephrotic proteinuria. The incidence of major complications was low. No procedure-related mortality was recorded in our study.

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