10.5152/turkjnephrol.2024.23510

Original Article

Turkish Journal of Nephrology

Frequency and Risk Factors of Ultrasound-Guided Kidney Biopsy

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ABSTRACT

Background: Kidney biopsy (KB) is the gold standard in the diagnosis of kidney diseases. Ultrasound (USG)-guided and automatic biopsy guns have decreased the complications. In our study, we examined the complications of KB performed using the routine kidney USG protocol performed during and 24 hours after the procedure. We also examined risk factors that may predict complications.

Methods: Major complications after biopsy were defined as bleeding requiring transfusion or surgical intervention. Minor complications were defined as hematoma not requiring transfusion, accompanied by hemoglobin (Hb) decrease of more than 1 g/dL. Ultrasound-guided automatic biopsy device and 18-gauge needle were used. Control USG was performed immediately after the biopsy and 24 hours after the procedure.

Results: Two hundred fifty-nine biopsy procedures were analyzed. Major complications were found in 15 (5.8%), minor complications in 22 (8.5%) patients. Of the 62 patients who developed hematoma after biopsy, 24 hematomas (38.7%) occurred immediately, and 38 hematomas (61.3%) were detected after 24 hours by the control USG. The low Hb and serological marker (antinuclear antibody, antineutrophil cytoplasmic antibody, and anti-glomerular basement membrane antibody) positivity were statistically significant in terms of major complications after KB.

Conclusion: Clinical follow-up for at least 24 hours, routine 24-hour control USG and early intervention (transfusion) may have prevented more severe clinical findings and complications. The low complication rate and the ability to obtain sufficient tissue make smaller-gauge needles advantageous. Low hemoglobin levels before biopsy and serological marker positivity were found to be independent risk factors for major complications.

Keywords: Complication, hemoglobin, kidney biopsy, ultrasound-guided

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Received: June 15, 2023 **Revision requested:** September 28, 2023 **Last revision received:** October 15, 2023 **Accepted:** November 17, 2023 **Publication Date:** April 18, 2024

Cite this article as: Demirelli B, Boynueğri B, Boztepe B, et al. Frequency and risk factors of ultrasound-guided kidney biopsy. *Turk J Nephrol.* 2024;33(3):252-258.

INTRODUCTION

Kidney biopsy (KB) is an essential tool in nephrology to ensure a correct diagnosis, predict the prognosis, and enable optimal treatment for patients. Indications for KB are proteinuria, microscopic hematuria, kidney involvement of systemic disease, and unexplained kidney failure.[1] Contraindications for KB include bleeding diathesis, pyelonephritis, small kidney size, hydronephrosis, and uncontrolled hypertension.[2] Since it is an invasive technique, there is a possibility of complications. Complications requiring intervention and death have decreased considerably since it is performed using radiological imaging and automatic biopsy guns. Major bleeding requiring immediate intervention, such as transfusion or embolization, is rare but has a wide incidence range (<1%-9%).[3,4] In previous studies, risk factors for bleeding complications were found to be operator experience, number of needle passes, high blood pressure, impaired hemostasis, and low hemoglobin (Hb) level.[5] A thorough understanding of risk factors

is important for physicians to perform appropriate kidney biopsies to actively minimize the risk of biopsy-related complications. The timing of complications is also variable, and this has led to uncertainty regarding the optimal length of postprocedure follow-up. Some studies advocate observation periods of up to 24 hours, while others suggest that shorter observation periods are sufficient to determine major complications.[4,6]

In this study, we examined the complications of a KB performed with the routine kidney ultrasound (USG) protocol during and 24 hours after the procedure and the risk factors that may affect it.

MATERIAL AND METHODS

Data Recording

Two hundred fifty-nine biopsy procedures performed in our hospital between 2018 and 2022 were reviewed retrospectively. All patients who underwent KB without exclusion criteria were included in the study. Pre- and postbiopsy clinical findings, tests (urea, creatinine, CRP, albumin, hemogram, INR, sedimentation, serological tests (antinuclear antibody (ANA), antineutrophil cytoplasmic antibody (ANCA), anti-glomerular basement membrane (anti-GBM) antibody)), urine protein, USG findings, demographic characteristics, and biopsy reports of the patients were recorded. The estimated GFR (eGFR) was calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) 2021 formula.

Ultrasound Findings

Kidney USG before and after the biopsy was performed by an interventional radiologist. The presence of kidney parenchymal disease (KPD) was determined by comparing the echogenicity of the kidney parenchyma with the liver on kidney ultrasound. Staging was as follows:

Grade 0: Kidney parenchyma is less echogenic than the liver.
Grade 1: Kidney parenchyma has the same echogenicity as the liver.
Grade 2: Kidney parenchyma has more echogenicity than that of the liver.
Grade 3: Kidney parenchyma has more echogenicity than that of the liver and poor corticomedullary distinction.
Grade 4: Kidney parenchyma has more echogenicity than that of the liver, and corticomedullary distinction is lost. Increased echogenicity in grades 1 and above was considered KPD.

In addition, kidney parenchyma thickness was measured and expressed in millimeters.

Complication Definition

The patients were divided into 3 groups according to their postbiopsy findings:

Major complication

- Bleeding requiring erythrocyte suspension (ES) transfusion (accompanied by hematuria or hematoma on USG) or surgical intervention (such as nephrectomy or angiography)
- Hematoma with clinical findings other than hematuria
- Process-related infections such as pyelonephritis, arteriovenous fistula, and organ injury

Minor complication

- Hematoma with a hemoglobin (Hb) decrease of more than 1 g/dL but not requiring transfusion
- Gross hematuria not requiring intervention and transfusion

Noncomplicated hematoma

- Kidney hematoma seen on control USG without the findings described above

Biopsy Protocol

All patients were hospitalized and monitored for at least 24 hours. All patients were considered to have blood pressure below 140/90 mm Hg, Hb above 8 g/dL, an international normalized ratio (INR) derived from prothrombin time below 1.4 and platelet count above 50 $10^3/\mu L$ before biopsy. Bleeding diathesis and an active urinary tract infection were excluded. Antiplatelet drugs (acetylsalicylate, clopidogrel, ticagrelor, and prasugrel) were discontinued 5 days in advance unless contraindicated, and anticoagulant drugs (apixaban, dabigatran, edoxaban, rivaroxaban, and warfarin) were discontinued according to the protocols. It was aimed at reducing uremic toxins by performing intensive hemodialysis before biopsy in patients who were receiving hemodialysis treatment. In addition, prophylactic hemodialysis was performed in patients with eGFR below 15 mL/min/1.73 m^2 and blood urea nitrogen (BUN) >70 mg/dL (urea >150 mg/dL). Biopsy was performed by a single interventional radiologist with the same protocol and devices for all patients. A native kidney biopsy was performed in the prone position with a pillow under the abdomen to reduce lumbar lordosis, and a transplant kidney biopsy was performed in the supine position under ultrasound guidance. Local anesthesia was applied after skin sterilization. Two 1 cm-long kidney cores were obtained with 2 accesses using an automatic spring biopsy device and an 18-gauge needle (CR Bard Inc., Covington, GA, USA). After the biopsy, vital signs, clinical findings, and symptoms were monitored. Hemograms

MAIN POINTS

- Immune diseases with antinuclear antibody, antineutrophil cytoplasmic antibody, and anti-glomerular basement membrane antibody positivity and a low hemoglobin value before biopsy are risk factors for major postbiopsy complications.
- Routine follow-up with an ultrasound immediately and 24 hours after the biopsy can be valuable in predicting complications.
- The low complication rate and the ability to obtain sufficient tissue make smaller-gauge needles advantageous.

and complete urine tests were performed 2-3 times at 4-6-hour intervals. In the absence of significant Hb decrease, symptoms, and gross hemorrhage, patients were instructed to mobilize after 8 hours of supine position in bed. All patients underwent control USG immediately after biopsy and 24 hours after the procedure. Before discharge, it was observed that the hematoma had shrunk, the Hb decrease was not persistent, and clinical findings had regressed. Detailed written and oral information on the study was provided to the patients, and the doctors obtained written informed consent. Ethics committee approval was received for this study from the ethics committee of Haydarpasa Numune Education and Research Hospital (HNEAH-KAEK/KK/ 2022/199) (Date: 10/10/2022, Number: 2022/199-3910). Based on previous publications, the criteria for an adequate biopsy were at least 10 glomeruli for light microscopy and at least 1 glomerulus for immunofluorescence.[7]

Statistical Analysis

The Statistical Package for the Social Sciences Statistics software, version 23.0 (IBM SPSS Corp.; Armonk, NY, USA) was used for statistical analyses. As descriptive statistical methods, mean ± standard deviation was used for continuous numerical variables with and without a normal distribution and number and percentage were used for categorical variables. An independent sample *t*-test was used for normally distributed numerical variables; Mann–Whitney *U*-test was used for non-normally distributed variables; and chi-square test and Fisher's exact test were used for categorical variables. Parameters that were significant for the occurrence of major complications after kidney biopsy in univariate analysis and did not show multicollinearity were included in binary logistic regression analysis. The backward LR strategy was applied in multivariate analysis. Risk estimates were presented as unadjusted odds ratio (OR) and adjusted odds ratios (AOR) with 95% CI. The Hosmer–Lemeshow statistic was used to determine model fit in logistic regression analysis. $P < .05$ was considered statistically significant.

RESULTS

Two hundred fifty-nine biopsies were performed percutaneously under USG guidance. The most common reasons for biopsy were proteinuria (175, 67.6%) and acute kidney injury (77, 29.7%). The frequencies of pathological diagnoses are shown in Figure 1. Fifty-nine biopsy procedures (22%) were performed on the transplant kidney.

Major complications were found in 15 (5.8%), minor complications in 22 (8.5%), and noncomplicated hematoma in 33 (12.7%) patients. A total of 37 patients (14.3%) had complications. Hematoma was detected by USG in 62 (23%) patients. In 237 patients, microscopic hematuria (94.9%) was detected after biopsy.

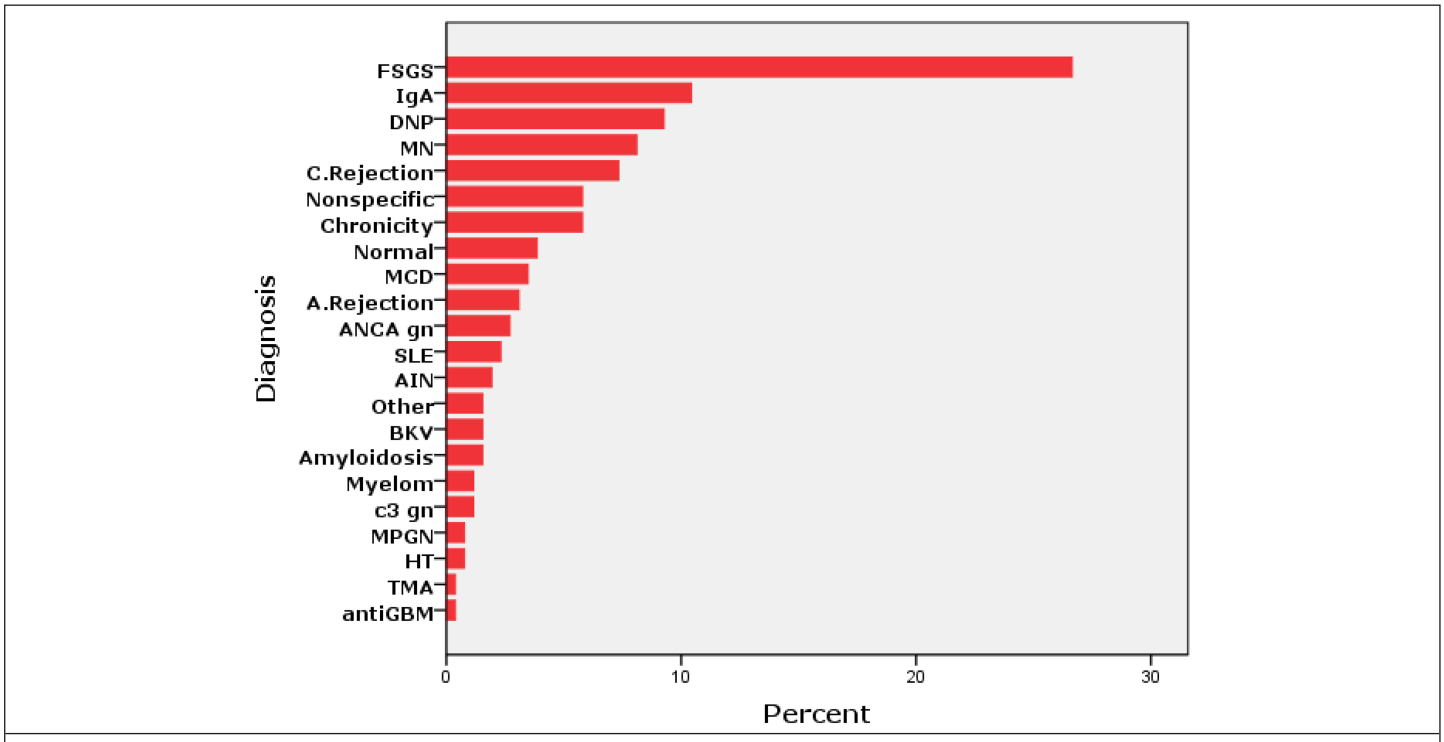

Figure 1. The frequency of diseases according to biopsy results. FSGS, focal segmental glomerulosclerosis; IgA, IgA nephropathy; DNP, diabetic nephropathy; MN, membranous nephropathy; C.Rejection, chronic allograft rejection; MCD, minimal change disease; A.Rejection, acute allograft rejection; SLE, systemic lupus erythematosus; AIN, acute interstitial nephritis; ANCA gn, antineutrophil cytoplasmic antibody-associated glomerulonephritis; BKV, BK virus-associated nephropathy; c3 gn, c3 glomerulopathy; MPGN, membranoproliferative glomerulonephritis; HT, hypertensive nephrosclerosis; TMA, thrombotic microangiopathy; antiGBM, anti-glomerular basement membrane antibody nephritis. *Chronicity: total glomerulosclerosis and severe tubular atrophy.

Erythrocyte suspension replacement was performed in all patients with major complications due to hematoma or hematuria. No patient underwent radiologic interventional or surgical procedures due to bleeding. In 8 of the patients with major complications, hematoma was detected by USG. In the remaining 6 patients, hematuria was present, although no hematoma was detected in the USG performed at 0 and 24 hours. Although there was no USG finding at the 0th hour, hematoma was detected at the 24-hour USG in 5 out of 8 (62%) patients with hematoma.

Of the 62 patients who developed hematoma after biopsy, 24 (38.7%) had hematoma immediately after biopsy, and 38 (61.3%) had hematoma 24 hours after biopsy on control USG. All patients who developed hematoma immediately after biopsy showed regression of the hematoma on control USG 24 hours later. After 24 hours, all patients with hematoma on control USG were discharged when control Hb values and clinical findings were stable. Only 2 patients had a hematoma size of 6 cm; the other patients had a hematoma size of less than 2 cm. Three patients underwent a repeat biopsy because of insufficient biopsy material. Biopsy adequacy was 98.9%.

Patients who received hemodialysis treatment or had an eGFR below 15 mL/min/1.73 m^2 (n = 30) were divided into 2 groups as those who received (n = 8) desmopressin (iv, in a dose of 0.3 microgram/kg and infusion just before the procedure) treatment before biopsy and not (n = 22). The frequency of major complications in patients who received desmopressin treatment (5 patients, 62.5%) was found to be higher than those who did not (3 patients, 22.7%). It was interpreted as borderline statistically significant (*P* = .056). The mean urea level of the patients whose eGFR was below 15 mL/min/1.73 m^2 and who were not treated with HD before the procedure was 107 ± 39.8 mg/dL. The maximum urea level was 160 mg/dL. Patients at high risk for bleeding were treated with prophylactic hemodialysis (urea >150 mg/dL, BUN >70mg/dL).

When the patients were divided according to the presence of major complications, acute kidney injury (85.4% vs. 14.6%, *P* = .001), hemodialysis treatment during/before biopsy (73.7% vs. 26.3%, *P* = .002), evidence of kidney parenchymal disease by USG (89.2% vs. 10.8%, *P* = .01), serological marker (ANA, ANCA, anti-GBM antibody) positivity (81.8% vs. 18.2%, *P* = .006), native right kidney biopsy (86.1% vs. 13.9%, *P* = .04), advanced age (46.2 ± 14.5 vs. 56 ± 10.4, *P* = .01), kidney failure/low eGFR (62.3 ± 34.6 vs. 19.6 ± 12.1, *P* = .001), low platelets (247 ± 76 vs. 189 ± 88, *P* = .005) and hemoglobin (12 ± 2 vs. 9.4 ± 0.6, *P* = .001), postbiopsy Hb decrease (0.66 ± 0.52 vs. 1 ± 0.5, *P* = .016), elevated CRP (6.5 ± 13 vs. 20.3 ± 26.3, *P* = .001) and low serum albumin (3.2 ± 0.6 vs. 3 ± 1.1, *P* = .03) were significantly higher in the major complication arm (Table 1).

According to multivariate analysis, low Hb (OR 0.3; 95% CI, 0.175-0.828; *P* = .01) and positive serology (OR 4.73; 95% CI, 1.06-20.09; *P* = 0.04) were statistically significant for major complications after kidney biopsy. Advanced age (OR 1.05; 95% CI, 0.997-1.107; *P* = 0.06) and low eGFR (OR 0.96; 95% CI, 0.923-1.006; *P* = .06) were found to be borderline significant (Table 2).

DISCUSSION

Postbiopsy complications have decreased following the improvement of biopsy protocols. Bleeding complications such as microscopic hematuria, perinephritic hematoma, and macroscopic hematuria requiring blood transfusion and/or surgical or radiological interventions are usually the most common complications.[8-10] The definition of major complications differs in studies, and it is generally accepted as ES replacement due to bleeding and conditions that require intervention. Major complication rates vary between 1.2% and 6.4% in studies.[2,6,11,12] In our study, this rate was 5.8%. No intervention was required in any patient (0%). Although there are no clear standards or threshold for ES transfusion in the literature, symptomatic anemia (hypotension, tachycardia, and fatigue due to anemia) is accepted as an indication. In our protocol, transfusion was performed when the Hb level fell below 8 g/dL with or without symptomatic anemia. We set this level at 8 g/dL because the patients diagnosed with kidney failure are prone to cardiovascular diseases, systemic and kidney perfusion should be preserved, and anemia symptoms are sometimes less obvious. Although this threshold level means an additional number of patients in the major complication group, in our opinion, it is at a level where the favorable effects of ES transfusion outweigh the risks. Clinical follow-up for at least 24 hours, routine 24-hour control USG, and early intervention (transfusion) may have prevented more severe clinical findings and complications. Although our patients did not require nephrectomy and angiographic procedures, the relatively increased rate of major complications due to ES transfusion can be explained in this framework.

In addition to major complications, minor bleeding complications are also important, as they are associated with an increased length of hospital stay and health expenditures.[12] The frequency of minor complications and hematomas was found to be between 7.5% and 58.6% in other studies.[4,12-14] The large variability in incidence may be due to different patient populations and definitions of complications. In addition, in most studies, control USG is performed after the clinical symptoms of the complication occur, which may lead to underestimation of findings such as hematoma that do not cause clinical symptoms. In our study, minor bleeding complications (minor complications and noncomplicated hematoma) were detected in 21.2% of the patients, and the relatively high frequency may be due to the routine USG performed after biopsy even in the absence of symptoms.

Ultrasound is a valuable tool in biopsy preparation, guidance, detection of complications, and follow-up. Although USG-guided biopsy is standard in most centers postbiopsy

Table 1. Clinical, Biochemical, and Radiological Examinations of the Patients and Their Significance in Terms of Major Complications According to Univariate Analysis

Parameter	Number of Biopsies (n = 259)	No Major Complications (n = 244)	Major Complications (n = 15)	*P* (< .05)
Categorical Variables n (%)				
Female	114 (44)	108 (94.7)	6 (5.3)	.74
Hypertension	178 (68.7)	168 (94.3)	10 (5.7)	.53
Diabetes mellitus	72 (27)	70 (97.2)	2 (2.8)	.16
Acute kidney failure	82 (31)	70 (85.4)	12 (14.6)	.001
Chronic kidney disease	116 (44)	107 (92.2)	9 (7.8)	.2
ACEi/ARB use	127 (49)	120 (86.7)	7 (13.3)	.091
Antiaggregant drug use	43 (16)	39 (94.5)	4 (5.5)	.22
Hemodialysis before biopsy	19 (7)	14 (73.7)	5 (26.3)	.002
Immunosuppressive drug use	68 (26)	66 (97.1)	2 (2.9)	.19
Anticoagulant drug use	10 (3)	10 (100)	0(0)	.5
KPD (USG)	93 (35)	83 (89.2)	10 (10.8)	.01
Positive serology	33 (12)	27 (81.8)	6 (18.2)	.006
Transplant kidney biopsy	59 (22)	56 (94.9)	3 (5.1)	.5
Native right kidney biopsy (n = 200)[+]	36 (18)	31 (86.1)	5 (13.9)	.04
Tubular atrophy/fibrosis[*]	137 (48)	126 (92)	11(8)	.1
Postbiopsy hematuria	237 (91)	223 (94.1)	14 (5.9)	.6
Numeric Variables (Mean ± SD)				
Age, years	46 ± 14	46.2 ± 14.5	56 ± 10.4	.01
Height, cm	166 ± 9	166.8 ± 9.1	167.6 ± 8.1	.7
Weight, kg	76 ± 16	77.1 ± 16.2	71 ± 13.2	.2
BMI, kg/m^2	27.5 ± 5.1	27.6 ± 5.2	25.5 ± 4.2	.1
Number of glomeruli	19.2 ± 9.8	19.1 ± 9.8	21.4 ± 9.8	.2
Hemoglobin, g/dL	11.9 ± 2	12 ± 2	9.4 ± 0.6	.001
Hb drop, g/dL	0.6 ± 0.5	0.66 ± 0.52	1 ± 0.5	.016
Pt count	244 ± 78	247 ± 76	189 ± 88	.005
INR	0.97 ± 0.09	0.98 ± 0.09	1.02 ± 0.14	.6
Creatinine, mg/dL	1.7 ± 1.1	1.6 ± 1.09	3.2 ± 1.1	.01
Urea, mg/dL	59.5 ± 36.5	57.8 ± 35.3	86 ± 47.2	.01
eGFR, mL/min/1.73 m^2	59.8 ± 35.2	62.3 ±34.6	19.6 ± 12.1	.001
CRP, mg/L	20.3 ± 26.3	6.5 ± 13	20.3 ± 26.3	.001
Serum albumin, g/dL	3.2 ± 0.7	3.2 ± 0.6	3 ± 1.1	.03
Sedimentation, mm/h (n = 215)	30.7 ± 22.9	30.3 ± 22.6	36.5 ± 26.7	.4
Proteinuria, g/day	4.1 ± 3.4	4.1 ± 3.4	3.5 ± 3.4	.3
Kidney size, mm	115 ± 10.5	115 ± 10.2	119 ± 13	.15
Kidney parenchyma thickness, mm	14.4 ± 2.7	14.5 ± 2.7	14.4 ± 3.3	.8

eGFR was calculated with 2021 CKD-EPI formula. Positive serology refers to ANA, ANCA, and anti-GB positivity.
ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; BMI, body mass index; eGFR, estimated glomerular filtration rate; Hb, hemoglobin; INR, international normalized ratio; KPD, kidney parenchymal disease; Pt, platelet; USG, ultrasound.
*Pathology findings.[+]The right kidney was preferred in 200 patients undergoing native kidney biopsy.

Table 2. Multivariate Analysis Results

Parameter	*P*	OR	95% CI	
			Low	High
Age	.06	1.05	0.997	1.107
Hemoglobin g/dL	**.01**	0.3	0.175	0.828
Positive serology	**.04**	4.73	1.06	20.09
KPD (USG)	.47	1.63	0.426	6.279
eGFR, mL/min/1.73 m^2	.06	0.96	0.923	1.006

eGFR was calculated with 2021 CKD-EPI formula. Positive serology refers to ANA, ANCA, and anti-GB positivity.
eGFR, estimated glomerular filtration; KPD, kidney parenchymal disease, OR, odds ratio; USG, ultrasound.

evaluation is not always part of a standard procedure. Some studies have reported that postbiopsy control USG is sufficient to detect possible bleeding events and improve the management of patients with complications.[15-17] Hematoma was detected in 8 of the patients with major complications, and in most of these patients, hematoma was detected in the control USG performed 24 hours after the procedure rather than in the USG performed immediately after the procedure. In addition, hematoma was seen at 24-hour USG in most patients with hematoma. Especially in patients who are at risk for hemorrhage, USG at 24 hours seems to be valuable in predicting complications and making discharge decisions in addition to routine clinical and biochemical follow-up.

In this study, the success rate of obtaining sufficient samples by needle biopsy was 98.9%, which is similar to previous studies (98%-100%).[12] In previous studies, larger diameter biopsy needles (14-16 gauge) were used to obtain tissue containing an average of 14-16 glomeruli, whereas in our patients, the average number of glomeruli was 19 despite the use of an 18-gauge needle.[12,18] According to the KHA-CARI Guideline recommendations, a 16-gauge needle is the standard practice for KB.[19] It is plausible that smaller 18-gauge needles may reduce complications such as bleeding in high-risk patients. Therefore, a recent study has shown that a biopsy with an 18-gauge needle reduces the likelihood of complications compared to biopsy with a 16-gauge needle.[20] The low complication rate and the ability to obtain sufficient tissue make smaller-diameter needles advantageous in clinical use.

Although desmopressin treatment of patients at high risk of bleeding before biopsy has been shown to reduce the likelihood of bleeding,[21,22] we could not detect such an effect in our cohort. The small number of cases may have affected the analysis results, as we administered desmopressin to only 8 of 30 patients with an eGFR below 15 mL/min/1.73 m^2.

The aim of this study was to identify risk factors that may be clinically useful for predicting complications after native or transplant kidney biopsies. Risk factors that increase the risk of bleeding following kidney biopsy have been identified in the literature, including needle size, antiaggregant/anticoagulant drug use, comorbidities, the number of needle passes to obtain adequate kidney tissue, abnormal laboratory tests (e.g., azotemia, thrombocytopenia, prolonged INR or prothrombin time), and high blood pressure.[8,13,19] In our study, low Hb levels before biopsy and positive serology (ANA, ANCA, and anti-GBM antibody positivity) were found to be independent risk factors for major complications.

Whittier et al[23] found that the decision to transfuse after KB was influenced by the severity of initial anemia rather than clinically evident bleeding. However, in the same study, it was also found that the decrease in Hb was less in the group that transfused ES compared to the group that did not transfuse ES. In our study, although initial Hb levels were lower in patients with major complications, the amount of Hb decrease after biopsy was significantly higher. In spite of the fact that the patients with low baseline Hb levels were close to the lower threshold values for ES transfusion, the Hb decrease indicated that the patients were included in the major complication arm due to bleeding. Low Hb may increase bleeding tendency due to a low red blood cell count. In anemia, platelets tend to move further away from the endothelium and toward the center of the vessel, resulting in impaired adhesion in the case of tissue damage.

The fact that ANA-, ANCA-, and anti-GBM antibody-positive patients are more risky in terms of complications can be explained by susceptibility to bleeding, disruption of the integrity of small vessels and glomeruli due to inflammation, and comorbidities such as anemia and kidney injury that may increase the risk of bleeding. It was also found in our study that advanced age and kidney failure increased the likelihood of hemorrhage, with statistical borderline significance.

Our study had limitations. As our study was based on information collected from electronic medical records, we encountered incomplete data and difficulties in accessing the results of some previous laboratory tests, which are common limitations of retrospective studies. The small number of major complication events prevented us from reliably examining the predictive ability of more variables that may increase the risk of bleeding. In the major complication arm, there were patients who required ES replacement when the Hb level dropped to a relatively dangerous level without waiting for symptoms to develop. This may be considered an overestimation of the major complications. Major complications developed in only 3 of the kidney transplant patients. Since the number of complications was low in this group, transplanted and native kidney biopsies were considered together in order not to impair the statistical significance and power. Finally, preprocedural hypertension, abnormal bleeding parameters, evidence of urinary tract infection, and elevated urea levels, which were previously identified as bleeding risk factors, were excluded by our biopsy protocol.

In conclusion, our protocol with USG-guided biopsy with an 18-gauge needle, 24-hour clinical follow-up, and first-day control USG after biopsy was found to be favorable in terms of complications and biopsy efficacy. Baseline hemoglobin and autoinflammatory marker positivity were risk factors for major complications after the procedure.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Haydarpaşa Numune Education and Research Hospital (HNEAH-KAEK/KK/2022/199) (Date: 10/10/2022, Number: 2022/199-3910).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – B.D., M.B.O., Bu.B.; Design – Ba.B., B.D., M.C.; Supervision – M.B.O.; Resources – B.D., E.G.S.; Materials – A.R., G.G.; Data Collection and/or Processing – B.D., Bu.B.; Analysis and/or Interpretation – B.D.; Literature Search – B.D., Bu.B.; Writing Manuscript – B.B., Bu.B.; Critical Review – Ba.B., M.B.O.

Declaration of Interests: The authors have no conflict of interest to declare.

Funding: The authors declared that this study has received no financial support.

REFERENCES

1. Hull KL, Adenwalla SF, Topham P, Graham-Brown MP. Indications and considerations for kidney biopsy: an overview of clinical considerations for the non-specialist. *Clin Med (Lond)*. 2022;22(1):34-40. [CrossRef]
2. Peters B, Nasic S, Segelmark M. Clinical parameters predicting complications in native kidney biopsies. *Clin Kidney J*. 2020;13(4):654-659. [CrossRef]
3. Roth R, Parikh S, Makey D, et al. When size matters: diagnostic value of kidney biopsy according to the gauge of the biopsy needle. *Am J Nephrol*. 2013;37(3):249-254. [CrossRef]
4. Schorr M, Roshanov PS, Weir MA, House AA. Frequency, timing, and prediction of major bleeding complications from percutaneous renal biopsy. *Can J Kidney Health Dis*. 2020;7:2054358120923527. [CrossRef]
5. Tøndel C, Vikse BE, Bostad L, Svarstad E. Safety and complications of percutaneous kidney biopsies in 715 children and 8573 adults in Norway 1988-2010. *Clin J Am Soc Nephrol*. 2012;7(10):1591-1597. [CrossRef]
6. Simard-Meilleur MC, Troyanov S, Roy L, Dalaire E, Brachemi S. Risk factors and timing of native kidney biopsy complications. *Nephron Extra*. 2014;4(1):42-49. [CrossRef]
7. Geldenhuys L, Nicholson P, Sinha N, et al. Percutaneous native renal biopsy adequacy: a successful interdepartmental quality improvement activity. *Can J Kidney Health Dis*. 2015;2:8. [CrossRef]
8. Corapi KM, Chen JL, Balk EM, Gordon CE. Bleeding complications of native kidney biopsy: a systematic review and meta-analysis. *Am J Kidney Dis*. 2012;60(1):62-73. [CrossRef]
9. Varnell CD, Stone HK, Welge JA. Bleeding complications after pediatric kidney biopsy: a systematic review and meta-analysis. *Clin J Am Soc Nephrol*. 2019;14(1):57-65. [CrossRef]
10. Kajawo S, Ekrikpo U, Moloi MW, et al. A systematic review of complications associated with percutaneous native kidney biopsies in adults in low-and middle-income countries. *Kidney Int Rep*. 2021;6(1):78-90. [CrossRef]
11. Moledina DG, Luciano RL, Kukova L, et al. Kidney biopsy–related complications in hospitalized patients with acute kidney disease. *Clin J Am Soc Nephrol*. 2018;13(11):1633-1640. [CrossRef]
12. Manno C, Strippoli GF, Arnesano L, et al. Predictors of bleeding complications in percutaneous ultrasound-guided renal biopsy. *Kidney Int*. 2004;66(4):1570-1577. [CrossRef]
13. Xu DM, Chen M, Zhou FD, Zhao MH. Risk factors for severe bleeding complications in percutaneous renal biopsy. *Am J Med Sci*. 2017;353(3):230-235. [CrossRef]
14. Prasad N, Kumar S, Manjunath R, et al. Real-time ultrasound-guided percutaneous renal biopsy with needle guide by nephrologists decreases post-biopsy complications. *Clin Kidney J*. 2015;8(2):151-156. [CrossRef]
15. Franke M, Kramarczyk A, Taylan C, Maintz D, Hoppe B, Koerber F. Ultrasound-guided percutaneous renal biopsy in 295 children and adolescents: role of ultrasound and analysis of complications. *PLoS One*. 2014;9(12):e114737. [CrossRef]
16. Hirano D, Fujinaga S, Nishizaki N, Kanai H, Ida H. Role of ultrasound in revealing complications following percutaneous renal biopsy in children. *Clin Nephrol*. 2013;80(6):426-432. [CrossRef]
17. Gülcü A, Göktay Y, Soylu A, et al. Doppler US evaluation of renal biopsy complications in children. *Diagn Interv Radiol*. 2013;19(1):15-19. [CrossRef]
18. Gomes OV, de Almeida BAD, Santana LFE, et al. Ultrasound-guided percutaneous renal biopsy at a university hospital: retrospective analysis of success and complication rates. *Radiol Bras*. 2021;54(5):311-317. [CrossRef]
19. MacGinley R, Champion De Crespigny PJ, Gutman T, et al. KHA-CARI Guideline recommendations for renal biopsy. *Nephrology (Carlton)*. 2019;24(12):1205-1213. [CrossRef]
20. Xu S, Ma L, Lin J, Zhang Z, Wang X, Yin J. Efficacy and safety of percutaneous renal biopsy performed using 18G needle *versus* 16G needle: a single-center retrospective study. *Int Urol Nephrol*. 2022;54(12):3255-3261. [CrossRef]
21. Athavale A, Kulkarni H, Arslan CD, Hart P. Desmopressin and bleeding risk after percutaneous kidney biopsy. *BMC Nephrol*. 2019;20(1):413. [CrossRef]
22. Rao NS, Chandra A. Intranasal desmopressin reduces renal biopsy-related bleeding and serum sodium levels in patients with reduced renal function. *Clin Kidney J*. 2020;13(6):1063-1067. [CrossRef]
23. Whittier WL, Sayeed K, Korbet SM. Clinical factors influencing the decision to transfuse after percutaneous native kidney biopsy. *Clin Kidney J*. 2016;9(1):102-107. [CrossRef]