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Predictive Factors for Bleeding Complications after Ultrasound-guided Percutaneous Native Kidney Biopsy

Ultrason Eşliğinde Yapılan Perkütan Nativ Böbrek Biyopsisi Sonrası Kanama Komplikasyonlarını Öngören Faktörler

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ABSTRACT

Aim: Kidney biopsy is the gold standard for the diagnosis of parenchymal diseases of the kidney. The most common complication after kidney parenchymal biopsy is bleeding. The aim of this study was to investigate patient-related factors that increase the risk of bleeding complications after percutaneous native renal parenchymal biopsy.

Materials and Methods: A total of 132 patients who underwent percutaneous native kidney parenchymal biopsy were included in the study. Demographic data, comorbidities, indications for kidney biopsy, anticoagulant and/or antiaggregant drug use, blood pressure, hemoglobin (HGB), platelet, international normalised ratio (INR), glomerular filtration rate (GFR), urea, creatinine values recorded in patient files before biopsy, development of bleeding complications after biopsy, need for intervention for bleeding, need for transfusion and length of hospital stay due to bleeding were retrospectively analysed.

Results: Bleeding complications occurred in 17 patients (12.9%) after biopsy. Of the 17 patients with bleeding, 5 (3.8%) were major bleedings. No patient required embolisation or surgical intervention. A statistically significant correlation was observed between pre-procedural antiaggregant and/or anticoagulant drug use, HGB levels, INR and development of bleeding complications. In the group without bleeding complications, mean pre-procedure HGB; 11.5±2.45 g/dL and INR; 1.05±0.1, while in the bleeding group, HGB; 10±1.99 mg/dL and INR; 1.12±0.12 ($p=0.013$, $p=0.009$, respectively). A history of anticoagulant and/or antiaggregant use was 29.4% in the patients with bleeding and 10.4% in the group without bleeding ($p=0.045$).

Conclusion: Our study draws attention to the necessity of determining new safe limits especially in terms of haemogram, INR levels, anticoagulant and/or antiaggregant drug use parameters, defining the high-risk patient group and taking appropriate precautions before biopsy in order to perform percutaneous native renal parenchymal biopsy with a lower bleeding risk.

Keywords: Kidney biopsy, hemorrhage, risk factors

ÖZ

Amaç: Böbrek biyopsisi, böbreğin parankimal hastalıkların tanısında altın standarttır. Böbrek parankim biyopsisi sonrası en sık görülen komplikasyon kanamadır. Bu çalışmanın amacı perkütan nativ böbrek parankim biyopsisi sonrası kanama komplikasyonu riskini artıran hastaya ait faktörleri araştırmaktır.

Gereç ve Yöntem: Perkütan nativ böbrek parankim biyopsisi yapılan toplam 132 hasta çalışmaya dahil edildi. Hasta dosyalarında biyopsi öncesi kaydedilen demografik veriler, yandaş hastalıklar, böbrek biyopsisi endikasyonları, antikoagülan ve/veya antiagregan ilaç kullanımı, kan basıncı, hemoglobin (HGB), trombosit, uluslararası normalleştirilmiş oran (INR), glomerüler filtrasyon hızı, üre, kreatinin değerleri ile biyopsi sonrası kanama

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komplikasyonu gelişimi, kanamaya müdahale gereksinimi, transfüzyon ihtiyacı ve kanama nedeniyle hastanede kalış süresi retrospektif olarak incelendi.

Bulgular: Biyopsi sonrasında 17 hastada (%12,9) kanama komplikasyonu meydana geldi. Kanaması olan 17 hastanın 5'i (%3,8) majör kanamaydı. Hiçbir hastada embolizasyon veya cerrahi müdahale gerekmedi. İşlem öncesi antiagregan ve/veya antikoagülan ilaç kullanımı, HGB düzeyleri, INR ve kanama komplikasyonu gelişimi arasında istatistiksel olarak anlamlı bir ilişki gözlendi. Kanama komplikasyonu olmayan grupta işlem öncesi ortalama HGB;11,5±2,45 g/dL ve INR; 1,05±0,1 iken, kanama grubunda HGB; 10±1,99 mg/dL ve INR; 1,12±0,12 saptandı (Sırasıyla p=0,013, p=0,009). Kanama saptanan hastalarda antikoagülan ve/veya antiagregan kullanım öyküsü %29,4 iken kanama olmayan grupta %10,4 saptandı (p=0,045).

Sonuç: Çalışmamız, perkütan nativ böbrek parankim biyopsisinin daha düşük kanama riskiyle uygulanabilmesi için biyopsi öncesi özellikle hemogram, INR düzeyleri, antikoagülan ve/veya antiagregan ilaç kullanımı parametreleri açısından yeni güvenli sınırların belirlenmesi, yüksek riskli hasta grubunun tanımlanması ve uygun önlemlerin alınması gerekliliğine dikkat çekmektedir.

Anahtar Kelimeler: Böbrek biyopsisi, kanama, risk faktörleri

INTRODUCTION

Kidney biopsy is the gold standard for diagnosing kidney parenchymal diseases[1]. Kidney biopsies can be performed using open surgical methods, laparoscopy, and percutaneous techniques guided by imaging. Among these, percutaneous kidney parenchymal biopsies are most commonly conducted under ultrasound (US) guidance[1].

In a large-scale study including percutaneous biopsies of transplanted kidneys and other organs, the highest rate of major bleeding was observed following native kidney biopsies[2]. Consistently, bleeding is also the most common complication after percutaneous native kidney biopsy[3,4]. Reported bleeding rates after percutaneous native kidney biopsy vary considerably in the literature due to the heterogeneity of study designs, different definitions of complications, and the predominance of single-centre experiences[4,5]. A meta-analysis by Poggio et al.[3] reported the incidence of perinephric hematoma as 11%. However, in studies where routine post-biopsy imaging was performed regardless of clinical symptoms, perinephric hematoma rates exceeding 80% have been reported[6,7]. Bleeding-related complications are often detected 12-24 hours after the procedure[4,8]. Various risk factors associated with the patient's characteristics, accompanying diseases, and medications (especially antiplatelet and anticoagulant agents), the centre, the technique of the procedure, and the equipment used in the procedure may lead to bleeding complications[8,9]. The aim of this study in our centre was to evaluate the incidence of bleeding complications and associated risk factors after native kidney biopsies performed despite standard pre-biopsy preparations.

MATERIALS AND METHODS

A total of 143 consecutive patients who underwent US-guided percutaneous kidney biopsy at the Nephrology Clinic of Muğla Training and Research Hospital between October 2021 and August 2024 were retrospectively reviewed. Patients under 18 years of age, those who underwent biopsy of a transplanted kidney, and those who had biopsies performed to investigate malignancy in solid kidney masses were excluded from the study. After applying the exclusion criteria, 132 patients who underwent native kidney parenchymal biopsy were included in the final analysis. Ten patients were excluded due to undergoing a biopsy of a transplanted kidney, and another was excluded due to a biopsy performed for a solid kidney mass.

Ethical approval for this study was obtained from the Ethics Committee of the Faculty of Medicine and Health Sciences at Muğla University (decision no: 36, date: 27.02.2024).

Demographic information of the patients, comorbidities, use of anticoagulants and antiplatelet agents, pre-biopsy blood pressure, biochemical parameters [hemogram, blood urea nitrogen (BUN), glomerular filtration rate (GFR), creatinine, spot urine protein/creatinine ratio, prothrombin time (PT), international normalized ratio (INR)], indications for kidney biopsy, ultrasonographically measured kidney size, needle gauge, presence of bleeding complications, treatment applied in cases of bleeding and pathology results were recorded from patient files. Major bleeding complications are defined as those requiring treatment (blood transfusion, embolization, nephrectomy) or resulting in death, while minor bleeding complications are defined as those not requiring treatment.

At Muğla Training and Research Hospital, there is a standard procedure that must be followed for every patient who has been approved to undergo a kidney biopsy by the Interventional Radiology and Nephrology Departments. All percutaneous kidney biopsy procedures were performed by an interventional radiologist with 4 years of clinical experience in interventional radiology.

Pre-biopsy Preparation

Before the procedure, all patients were informed, and their consent was obtained. Patients taking antiplatelet agents or anticoagulants were referred to the relevant departments for risk evaluation prior to the biopsy.

If deemed appropriate, the medication may be discontinued; if not, a bridging therapy plan is discussed. For patients on antiplatelet therapy, the medication is stopped 5 days before the procedure and resumed 24 hours after. For those on warfarin, the patient is transitioned to low molecular weight heparin (LMWH) for bridging. Once an appropriate INR is achieved, the LMWH is discontinued 24 hours before the procedure and resumed 24 hours after.

One day prior to the procedure, patients' INR and platelet counts are checked. According to the guidelines published by the Cardiovascular and Interventional Radiological Society of Europe (CIRSE), interventional procedures are categorized into risk groups, with percutaneous kidney biopsies classified as high-risk[10]. It is routinely recommended to check INR, platelet count, and hematocrit levels before these procedures[10]. Before the procedure, the INR should be less than 1.5, and the platelet count needs to exceed 50,000/mm^3. In our department, having an INR below 1.5 and a platelet count above 50,000/mm^3 is considered an absolute requirement for performing a kidney biopsy.

One day prior to the biopsy procedure, all patients undergo an US evaluation of their kidneys to assess kidney size, parenchyma echogenicity, presence of hydronephrosis, and any cystic or tumoral formations, as well as anatomical variations. The specific kidney to be biopsied and the method of biopsy are determined.

Percutaneous Kidney Biopsy Procedure and Follow-up

All percutaneous kidney biopsies were performed under local anesthesia. Procedures were conducted using real-time US guidance (Toshiba Aplio 500, Toshiba Corporation, Tokyo, Japan). A 16-gauge 10 cm (22 mm tissue embedding distance, 17 mm sample collection chamber) fully automatic Tru-cut biopsy needle (Geotek Healthcare Products, Ankara, Türkiye) was employed consistently across all cases. The number of cores taken during biopsy is at least two and at most three. Patients were positioned prone during the procedure. The Tru-cut biopsy gun penetrates the kidney capsule from the lower pole of the kidney, and tissue samples are obtained using a tangential technique parallel to the capsule. At the end of the procedure, an US is performed to check for bleeding. Each patient is re-evaluated with US for bleeding control two hours after the procedure. All patients are monitored as inpatients in the nephrology clinic for 24 hours following the procedure. All patients are advised to rest in bed for the first six hours post-biopsy. Complete blood count monitoring is conducted for all patients eight hours after the procedure and the following morning. For patients with a decrease in HGB levels, a control US is performed the next day for bleeding assessment.

Statistical Analysis

All statistical analyses were performed utilizing IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., 2017, Armonk, NY). The chi-square test or Fisher's exact probability test (for tables with minimum expected values below 5) was employed to compare categorical variables between two groups. Variables were summarized using frequencies and percentages. The normality of numerical variables was evaluated using the Kolmogorov-Smirnov test ($n \geq 50$) or the Shapiro-Wilk test ($n < 50$). Since the data did not conform to a normal distribution, the Mann-Whitney U test, a non-parametric alternative, was used to compare the two groups with and without bleeding. To assess changes in HGB concentrations before and after the intervention, the Wilcoxon signed-rank test was applied. In addition, for the variables found to be statistically significant, univariate logistic regression analysis was performed to calculate the odds ratios (ORs). All hypothesis tests were performed at a significance level of 0.05; p-values below this level were considered statistically significant.

RESULTS

A total of 132 kidney biopsy patients who underwent the procedure between October 2021 and August 2024 were included in our study. The mean age of the patients was 49.2±17.4 years. Of the patients, 54% were male and 46% were female. The most common comorbidities were hypertension (HT) in 53%, diabetes mellitus in 23.5%, cardiovascular disease in 12.1%, and malignancy in 8.3%. The most frequent indication for biopsy was nephrotic syndrome, occurring in 30.3% of cases (Table 1).

Baseline laboratory and radiological data of the patients in accordance with the routine preparation before the biopsy procedure are presented in Table 2.

Bleeding complications occurred in 17 patients (12.9%). Of the 17 patients with bleeding, 5 (3.8%) were classified as having major bleeding (requiring blood transfusion). None of the patients with bleeding needed embolization or surgical intervention (Table 3).

A statistically significant correlation was observed between pre-biopsy HGB levels, INR, and the occurrence of bleeding complications. In the group without bleeding complications, the mean pre-biopsy HGB value was 11.5±2.45 g/dL, while in the bleeding group, it was 10±1.99 g/dL ($p=0.013$). The INR value in the non-bleeding group was 1.05±0.1, whereas in the bleeding group it was 1.12±0.12 ($p=0.009$).

Among the 5 patients with bleeding complications, a history of antiplatelet (2 patients on ASA) or anticoagulant (1 patient on warfarin, 1 patient on direct oral anticoagulant, and 1

Table 1. Demographical and medical historical characteristics of patients

Characteristic	n (%) or mean ± SD (min-max)
Age (years)	49.2±17.4 (16-85)
Gender, n (%)	
Male	71 (53.8%)
Female	61 (46.2%)
Comorbidities, n (%)	
Diabetes	31 (23.5%)
Hypertension	70 (53.0%)
Cardiovascular disease	16 (12.1%)
Malignancy	11 (8.3%)
Connective tissue disease	10 (7.5%)
Anticoagulant/antiplatelet use, n (%)	17 (12.8%)
Acetylsalicylic acid	7 (5.3%)
Clopidogrel	1 (0.7%)
Clopidogrel + acetylsalicylic acid	1 (0.7%)
LMWH	2 (1.5%)
Warfarin transitioned to LMWH	3 (2.2%)
Edoxaban	1 (0.7%)
Rivaroxaban	2 (2.2%)
Biopsy indications, n (%)	
Hematuria + non-nephrotic proteinuria	14 (10.6%)
Isolated proteinuria	20 (15.2%)
Unexplained kidney failure	32 (24.2%)
Nephritic syndrome	26 (19.7%)
Nephrotic syndrome	40 (30.3%)
Total number of patients	**132 (100%)**

LMWH: Low molecular weight heparin, SD: Standard deviation

patient on rivaroxaban) use was noted in 29.4% of cases. There was a statistically significant association between the use of antiplatelet/anticoagulant therapy and bleeding complications (p=0.045). No statistically significant association was found between bleeding complications and other variables, including patient sex, age, comorbid conditions, BUN, creatinine levels, GFR, platelet count, biopsy indication, and pre-biopsy blood pressure (Table 4).

ROC analysis identified the optimal INR threshold for predicting post-biopsy bleeding as ≥1.095 [area under the curve: 0.695; 95% confidence interval (CI): 0.551-0.840]. Using this cut-off, bleeding occurred significantly more often in patients with INR ≥1.095 (12/47, 25.5%) compared with INR <1.095 (5/85, 5.9%) (p=0.001). Binary logistic regression using the categorized INR variable showed an OR of 5.49 (95% CI: 1.80-16.75, p=0.003), indicating that INR ≥1.095 is independently associated with increased bleeding risk.

Table 2. Pre-biopsy clinical, biochemical and radiological measures

Measures	mean ± SD (min-max)
Blood pressure (mmHg)	
Systolic	127.8±19.9 (90-160)
Diastolic	78.2±11.5 (50-110)
Biochemical data	
BUN (mg/dL)	65.6±41.2 (12.6-227.5)
Creatinine (mg/dL)	2.25±2.03 (0.42-12.1)
GFR (mL/min/1.73 m²)	57±41.2 (4.9-147)
INR	1.06±0.11 (0.85-1.50)
HGB (g/dL)	11.4±2.45 (6.8-17.0)
Platelet (mm³)	259,167±99,146 (24,100-606,000)
Proteinuria (mg/g)	3,202.6±2,803.2 (85-14,260)
Size of the biopsied kidney	n (%)
≥10 cm	119 (90.2%)
<10 cm	13 (9.8%)
Total number of patients	132 (100%)

BUN: Blood urea nitrogen, GFR: Glomerular filtration rate, INR: International normalized ratio, HGB: Hemoglobin, SD: Standard deviation

Table 3. Post-procedural bleeding complications, need for transfusion after bleeding, follow-up due to bleeding

Variable	n (%)
Bleeding complications	
Yes	17 (12.9%)
Major	5 (3.8%)
Minor	12 (9.1%)
No	115 (87.1%)
Need for transfusion	
Yes	5 (3.8%)
No	127 (96.2%)
Follow-up, days	
No	9 (6.8%)
3 days	2 (1.5%)
4 days	2 (1.5%)
8 days	1 (0.76%)
10 days	2 (1.5%)
14 days	1 (0.76%)
Total number of patients	132 (100%)

Lower pre-biopsy HGB levels were also identified as a risk factor for bleeding, with a protective effect observed per unit increase in HGB (p=0.020; OR=0.751; 95% CI: 0.590-0.957) (Table 5). Due to the limited number of cases with major bleeding, multivariate regression analysis was not conducted, as it would not yield statistically reliable results and may risk overfitting. The slight discrepancy between the Mann-Whitney U test and

Table 4. Association of clinical, biochemical and radiologic factors with bleeding complications after percutaneous native kidney biopsy

Factors	Bleeding (-)	Bleeding (+)	p-value
Age (years, mean ± SD)	49.7±17.04	45.5±19.72	0.445
Gender, n (%)			0.551
Female	52 (85.2%)	9 (14.8%)	
Male	63 (88.7%)	8 (11.3%)	
Comorbidities, n (%)			-
Diabetes	30 (96.8%)	1 (3.2%)	0.074
Hypertension	62 (88.6%)	8 (11.4%)	0.597
Cardiovascular disease	13 (81.3%)	3 (18.8%)	0.434
Malignancy	10 (90.9%)	1 (9.1%)	1.000
Use of anticoagulant/antiplatelet drugs, n (%)			**0.045**
Use	12 (70.6%)	5 (29.4%)	
No use	103 (89.6%)	12 (10.4%)	
Blood pressure (mmHg)			-
Systolic	128.2±19.8	125.1±20.8	0.627
Diastolic	78.3±11.2	77.5±13.7	0.606
Biopsy indications, n (%)			0.605
Hematuria + non-nephrotic proteinuria	13 (92.9%)	1 (7.1%)	
Isolated proteinuria	16 (80.0%)	4 (20.0%)	
Unexplained kidney failure	29 (90.6%)	3 (9.4%)	
Nephritic syndrome	21 (80.8%)	5 (19.2%)	
Nephrotic syndrome	36 (90.0%)	4 (10.0%)	
Biochemical factors			-
BUN (mg/dL)	65.1±40.0	69.2±49.8	0.900
Creatinine (mg/dL)	2.17±1.89	2.83±2.86	0.386
GFR (mL/min/1.73 m²)	57.9±40.7	50.9±45.1	0.411
INR	1.051±0.101	1.128±0.120	**0.009**
Pre-biopsy HGB (g/dL)	11.5±2.45	10.0±1.99	**0.013**
Platelet (mm³)	262,784±100,070	234,706±91,671	0.110
Size of the biopsied kidney (cm)			0.374
≥10 cm	105 (88.2%)	14 (11.8%)	
<10 cm	10 (76.9%)	3 (23.1%)	

BUN: Blood urea nitrogen, GFR: Glomerular filtration rate, INR: International normalized ratio, HGB: Hemoglobin, SD: Standard deviation

Table 5. Univariate binary logistic regression analysis of factors associated with bleeding

Variable	OR	95% CI	p-value
INR ≥1.095	5.49	1.80-16.75	0.003
Pre-biopsy HGB	0.751	0.590-0.957	0.020
Use of anticoagulant / antiplatelet drugs	3.576	1.075-11.903	0.038

The odds ratio for INR may be unstable due to the narrow INR range and the limited number of bleeding events in our cohort. Due to the low number of major bleeding events (n=5), all regression analyses were performed for any bleeding (major + minor)

OR: Odds ratio, CI: Confidence interval, INR: International normalized ratio, HGB: Hemoglobin

logistic regression p-values is attributable to differences in statistical methodology (rank-based vs. model-based analysis). In patients with bleeding, hemoglobin levels decreased significantly after biopsy according to the Wilcoxon signed-rank test (p=0.017).

DISCUSSION

In our study, the overall rate of bleeding complications following US-guided percutaneous kidney biopsy was 12.9%, with major and minor complications occurring in 3.8% and 9% of cases, respectively. These findings are consistent with previously published studies for both major and minor bleeding rates.

A meta-analysis conducted by Poggio et al.[3] in 2020, which included 118,064 biopsies, reported a bleeding complication rate identified by hematoma of 11%, indicating that our overall bleeding rate is similar. However, the rate of requiring blood transfusion in that meta-analysis was 1.6%, which is lower than the corresponding rate in our study[2]. In other studies focusing on native kidney biopsies, major bleeding complication rates ranged from 1.1% to 8%[5,11-15]. The major bleeding rate observed in our study falls within this wide range and ranks approximately in the middle of the reported values[5,11-15].

In the study by Korbet et al.[12], cystoscopy was required in 0.18%, radiological embolization in 0.85%, and the mortality rate was 0.09%; in the study by Halimi et al.[5], angiographic intervention was needed in 0.4%, and nephrectomy was performed in 0.1%; in Waldo et al.'s[11] study, radiological interventions were required in 1.2%; and in the study by Lees et al.[16], embolization was necessary in 0.4%, with a mortality rate of 0.04%. In our study, all 5 patients who experienced major bleeding were treated with blood transfusions only, and no interventional or surgical treatments were necessary. There was no organ loss (nephrectomy) or mortality. The low number of patients may have reduced the likelihood of detecting complications such as mortality, nephrectomy, or bleeding requiring interventional procedures. More than 30 kidney biopsies, with an average of 35.2 patients per year, were performed at our center by an experienced interventional radiologist. This moderate-volume of procedures likely contributed to the positive outcomes observed in our study. These results are consistent with those reported by Tøndel et al.[15].

In our study, the majority of bleeding complications (94.1%) were observed within the first 24 hours following the procedure, with only a single case (5.9%) identified at 120 hours post-biopsy. In alignment with recommendations from the literature aimed at ensuring reliable complication detection[17,18], our institutional protocol mandates a minimum of 24 hours of post-procedural monitoring for all patients. We therefore believe that this practice enabled the timely identification of the vast majority of potential complications.

Numerous studies in the literature have explored the association between coagulation tests including PT, partial thromboplastin time (PTT), INR and bleeding time (BT)—and post-biopsy bleeding complications. Although PT, PTT, and INR are routinely assessed prior to kidney biopsy, several studies have shown that, within acceptable reference ranges, these parameters are not significantly correlated with bleeding risk after biopsy[16,19]. In Whittier et al.[20] cohort, patients with lower baseline HGB exhibited progressively longer BT, although prolonged BT was not independently predictive of transfusion requirements or major bleeding events. In contrast to this study, in the study by Korbet et al.[12], BT >7.5 min was found to be among the features that predicted any complication after kidney biopsy. In a recent review it was suggested that INR and PTT values should be within normal ranges before performing a kidney biopsy[1]. However, in this review, the findings related to BT were considered controversial[1], and as noted in the CIRSE guidelines, BT has largely fallen out of favor in modern clinical practice for assessing bleeding risk due to conflicting evidence regarding its utility[10]. In our study, BT values were not included in the pre-biopsy assessment protocol, and PTT was not analyzed, as none of the patients were receiving intravenous unfractionated heparin.

We identified a statistically significant relationship between bleeding complications following percutaneous native kidney biopsy and pre-biopsy INR, HGB levels, and the use of anticoagulants and/or antiplatelet agents. According to our institutional protocol, an INR below 1.5 was deemed adequate for proceeding with kidney biopsy[10]. However, a notable finding in our cohort was that 35% (6 out of 17) of patients who developed bleeding complications had an INR exceeding the laboratory upper limit of 1.2. Furthermore, 50% (5 out of 10) of all patients with an INR above 1.2 experienced post-biopsy bleeding. These observations suggest that using a more stringent INR threshold, specifically maintaining the INR below the laboratory reference upper limit of 1.2 - as proposed in the review by Schnuelle et al.[1] - may provide enhanced safety in minimizing bleeding risks following percutaneous kidney biopsy.

Although the association between INR and bleeding was statistically significant, the observed (OR=5.49) should be evaluated cautiously. The point estimate should be interpreted with caution because of sparse data. This extreme value likely reflects the limited number of bleeding complications and the narrow INR distribution in our cohort rather than a true clinical effect. All biopsies were performed only when INR <1.5, and most values were clustered around 1.0-1.2, which may have amplified the apparent risk in the univariate model. No outliers or data errors were identified, and the observed effect is more likely attributable to quasi-separation than to model misspecification. Accordingly, the INR-bleeding relationship should be regarded as an indicative trend rather than a precise quantitative estimate.

In our study, we observed that anemia heightened the risk of bleeding complications following percutaneous native kidney biopsy, a finding that aligns with other published studies[5,13,14,21,22]. In a study by Pombas et al.[14], HGB levels below 10 g/dL were identified as a risk factor for major complications after kidney biopsy. Similarly, a study by Aaltonen et al.[22], which included outpatient and kidney transplant patients, found a correlation between anemia and bleeding complications. In the French cohort study by Halimi et al.[5], anemia was shown to

increase the risk of major bleeding by 3.47 times. In a cohort study by Palsson et al.[13], when patients with HGB levels <10 g/dL were compared to those with ≥10 g/dL, 14.5% of the anemic group required blood transfusions after biopsy, while only 1.2% of the non-anemic group needed transfusion. Given the observed associations between anemia and increased bleeding risk in our study, consistent with findings from larger cohorts, we hypothesize that low HGB levels may serve as a potentially modifiable risk factor for post-biopsy bleeding complications. However, further large-scale prospective studies are warranted to confirm this relationship and to guide pre-biopsy risk stratification.

According to our pre-biopsy protocol, antiplatelet and anticoagulant medications were discontinued prior to the procedure. However, we found that a history of using these medications was still associated with bleeding complications. This suggests that past use of these drugs may contribute to bleeding risk, even if discontinued. Due to the small number of cases, both medication groups (antiplatelets and anticoagulants) were evaluated together. Therefore, we cannot provide separate evidence for antiplatelet or anticoagulant use. However, there are studies in the literature with conflicting results regarding the use of antiplatelet drugs, particularly aspirin, in kidney biopsy. Some studies have found that aspirin use during biopsy increases the risk of bleeding[9,23], while others have shown no such increase[2,16,24]. A meta-analysis published in 2023, evaluating the effect of aspirin on bleeding complications after kidney biopsy, concluded that aspirin does not elevate the risk of major bleeding[25].

Kidney biopsy complications are generally minimized by discontinuing antiplatelet medications, including non-steroidal anti-inflammatory drugs (NSAIDs), prior to the procedure. It is typically advised to stop these medications 7-10 days before the biopsy to reduce the risk of bleeding[4,26]. Only in emergency situations should aspirin (100 mg) be continued[1,2,16,27]. For anticoagulants, it is recommended that warfarin be stopped 5 days prior, conventional heparin at least 6 hours prior, and direct Xa inhibitors 72 hours before the procedure[1,28]. At our center, antiplatelet therapy was discontinued 5 days before biopsy, which is shorter than the 7-10 days recommended in some reviews[1,4]. This should be considered a potential limitation and confounder. Additionally, our patients are not routinely questioned about the use of commonly used NSAIDs which may have antiplatelet effects. In our study, the use of anticoagulants and antiplatelet agents, even when discontinued according to established protocols, remained a significant risk factor for bleeding complications. Further research, particularly in elective biopsies, designed to address the pharmacological mechanisms of these drugs is needed to establish safe therapeutic windows for treated patients.

Study Limitations

Numerous studies have sought to identify risk factors associated with bleeding complications following US-guided percutaneous native kidney biopsy. These investigations have explored a wide range of variables, including patient age, sex, kidney size, needle gauge, the number of needle passes, comorbid conditions (e.g., HT, amyloidosis), as well as pre-biopsy laboratory parameters such as serum creatinine, BUN, and estimated glomerular filtration rate (eGFR)[12,15,16,19,29-34]. In our study, all biopsies were performed using a 16-gauge biopsy needle, with 2-3 passes targeting the kidney cortex. Biopsies were not conducted in patients whose kidneys measured less than 90 mm in longitudinal diameter or in those with poor corticomedullary differentiation on ultrasonography. As needle gauge was standardized in all cases, its association with bleeding complications could not be evaluated. Furthermore, we found no statistically significant association between post-biopsy bleeding complications and demographic or clinical factors such as age, sex, kidney size, comorbidities, biopsy indications, histopathological diagnoses, or degree of proteinuria. Contrary to the findings reported by Lees et al.[16], Monahan et al.[19], Tøndel et al.[15], and Korbet et al.[12] our analysis did not reveal any correlation between serum creatinine, BUN or eGFR values and the occurrence of bleeding complications. The retrospective design, single-center setting, and relatively small sample size of our study may have limited its statistical power to detect potential associations.

CONCLUSION

In conclusion, US-guided percutaneous native kidney biopsy remains an essential diagnostic tool with an acceptable safety profile. In our study, bleeding complications were consistent with prior reports and mainly occurred within 24 hours without major adverse outcomes. Pre-biopsy INR, anemia, and prior use of anticoagulants or antiplatelet agents were significantly associated with bleeding risk, while other clinical and demographic factors showed no correlation. Considering the limitations of our study, larger prospective multicenter studies are needed to better define bleeding risk factors and optimize biopsy protocols to enhance patient safety.

Ethics

Ethics Committee Approval: Ethical approval for this study was obtained from the Ethics Committee of the Faculty of Medicine and Health Sciences at Muğla University (decision no: 36, date: 27.02.2024).

Informed Consent: The retrospective design is a single-center setting study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: F.B.S., Concept: D.G.G., Design: M.E., Data Collection or Processing: M.G.Ö.S., Analysis or Interpretation: M.E., Literature Search: M.G.Ö.S., Writing: F.B.S., D.G.G.

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REFERENCES

1. Schnuelle P. Renal biopsy for diagnosis in kidney disease: indication, technique, and safety. J Clin Med. 2023;12:6424.
2. Atwell TD, Spanbauer JC, McMenomy BP, Stockland AH, Hesley GK, Schleck CD, et al. The timing and presentation of major hemorrhage after 18,947 image-guided percutaneous biopsies. AJR Am J Roentgenol. 2015;205:190-5.
3. Poggio ED, McClelland RL, Blank KN, Hansen S, Bansal S, Bomback AS, et al. Kidney precision medicine project. systematic review and meta-analysis of native kidney biopsy complications. Clin J Am Soc Nephrol. 2020;15:1595-602.
4. Hogan J, Mocanu M, Berns J. The native kidney biopsy: update and evidence for best practice. Clin J Am Soc Nephrol.2016;11:354-62.
5. Halimi JM, Gatault P, Longuet H, Barbet C, Bisson A, Sautenet B, et al. Major bleeding and risk of death after percutaneous native kidney biopsies: a French nationwide cohort study. Clin J Am Soc Nephrol. 2020;15:1587-94.
6. Ishikawa E, Nomura S, Hamaguchi T, Obe T, Inoue-Kiyohara M, Oosugi K et al. Ultrasonography as a predictor of overt bleeding after renal biopsy. Clin Exp Nephrol. 2009;13:325-31.
7. Tanaka K, Kitagawa M, Onishi A, Yamanari T, Ogawa-Akiyama A, Mise K, et al. Arterial stiffness is an independent risk factor for anemia after percutaneous native kidney biopsy. Kidney Blood Press Res. 2017;42:284-93.
8. Granata A, Distefano G, Pesce F, Battaglia Y, Suavo Bulzis P, Venturini M, et al. Performing an ultrasound-guided percutaneous needle kidney biopsy: an up-to-date procedural review. Diagnostics (Basel). 2021;11:2186.
9. Bonani M, Seeger H, Weber N, Lorenzen JM, Wütrich RP, Kistler AD. Safety of kidney biopsy when performed as an outpatient procedure. Kidney Blood Press Res. 2021;46:310-22.
10. Malloy PC, Grassi CJ, Kundu S, Gervais DA, Miller DL, Osnis RB, et al. Consensus guidelines for periprocedural management of coagulation status and hemostasis risk in percutaneous image-guided interventions. J Vasc Interv Radiol. 2009;20(7 Suppl):S240-9.
11. Waldo B, Korbet SM, Freimanis MG, Lewis EJ. The value of post-biopsy ultrasound in predicting complications after percutaneous renal biopsy of native kidneys. Nephrol Dial Transplant. 2009;24:2433-9.
12. Korbet SM, Volpini KC, Whittier WL. Percutaneous renal biopsy of native kidneys: a single-center experience of 1,055 biopsies. Am J Nephrol. 2014;39:153-62.
13. Palsson R, Short SAP, Kibbelaar ZA, Amodu A, Stillman I, Renke HG, et al. Bleeding complications after percutaneous native kidney biopsy: results from the boston kidney biopsy cohort. Kidney Int Rep. 2020;5:511-8.
14. Pombas B, Rodríguez E, Sánchez J, Rodasevic A, Gimeno J, Busto M, B et al. Risk factors associated with major complications after ultrasound-guided percutaneous renal biopsy of native kidneys. Kidney Blood Press Res. 2020;45:122-30.
15. 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;7:1591-7.
16. Lees JS, McQuarrie EP, Mordi N, Geddes CC, Fox JG, Mackinnon B. Risk factors for bleeding complications after nephrologist-performed native renal biopsy. Clin Kidney J. 2017;10:573-7.
17. Whittier WL, Korbet SM. Timing of complications in percutaneous renal biopsy. J Am Soc Nephrol. 2004;15:142-7.
18. Prasad N, Kumar S, Manjunath R, Bhadauria D, Kaul A, Sharma RK, et al. Real time ultrasound-guided percutaneous renal biopsy with needle guide by nephrologists decreases post-biopsy complications. Clin Kidney J. 2015;8:151-6.
19. Monahan H, Gunderson T, Greene E, Schmit G, Atwel T, Schmitz J. Risk factors associated with significant bleeding events after ultrasound-guided percutaneous native renal biopsies: a review of 2204 cases. Abdominal Radiology.2019;44:2316-22.
20. Whittier WL, Sayeed K, Korbet SM. Clinical factors influencing the decision to transfuse after percutaneous native kidney biopsy. Abdom Radiol (NY). 2019;44:2316-22.
21. Pendón-Ruiz de Mier MV, Espinosa-Hernández M, Rodelo-Haad C, Esquivias-de Motta E, Gómez-Carrasco J, Ortega R, et al. Prospective study of the complications associated with percutaneous renal biopsy of native kidneys: experience in a centre. Nefrologia. 2014;34:383-7.
22. Aaltonen S, Finne P, Honkanen E. Outpatient kidney biopsy: a single center experience and review of literature. Nephron. 2020;144:14-20.
23. Potretzke TA, Harvey JA, Gunderson TM, Jensen NM, Schmit GD, McBane RD, et al. Frequency of bleeding complications after percutaneous core needle biopsy and the association with aspirin usage and length of aspirin discontinuation. AJR Am J Roentgenol. 2019;213:211-5.
24. Fontana F, Cazzato S, Giaroni F, Bertolini F, Alfano G, Mori G, et al. Risk of bleeding after percutaneous native kidney biopsy in patients receiving low-dose aspirin: a single-center retrospective study. J Nephrol. 2023;36:475-83.
25. Relvas M, Gonçalves J, Castro I, Diniz H, Mendonça L, Coentrão L (2023). Effects of aspirin on kidney biopsy bleeding complications: a systematic review and meta-analysis. Kidney360. 2023;4:700-10.
26. Luciano RL, Moeckel GW. Update on the native kidney biopsy: core curriculum 2019. Am J Kidney Dis. 2019;73:404-15.
27. Kumar V, Mitchell MD, Umscheid CA, Berns JS, Hogan JJ. Risk of complications with use of aspirin during renal biopsy: a systematic review. Clin Nephrol. 2018;89:67-76.
28. Brachemi S, Bollée G. Renal biopsy practice: what is the gold standard? World J Nephrol. 2014;3:287-94.
29. Peters B, Nasic S, Segelmark M. Clinical parameters predicting complications in native kidney biopsies. Clin Kidney J. 2019;13:654-9.
30. Trajceska L, Severova-Andreevska G, Dzekova-Vidimliski P, Nikolov I, Selim G, Spasovski G, et al. Complications and risks of percutaneous renal biopsy. Open Access Maced J Med Sci. 2019;7:992-5.
31. Antunes PRB, Prado FFM, de Souza FTA, de Siqueira EC, de Campos MÁ, Álvares MCB, et al. Clinical complications in renal biopsy using two different needle gauges: the impact of large hematomas, a random clinical trial study. Int J Urol. 2018;25:544-8.
32. Kriegshauser JS, Patel MD, Young SW, Chen F, Eversman WG, Chang YH. Risk of bleeding after native renal biopsy as a function of preprocedural systolic and diastolic blood pressure. J Vasc Interv Radiol. 2015;26:206-12.
33. Eiro M, Katoh T, Watanabe T. Risk factors for bleeding complications in percutaneous renal biopsy. Clin Exp Nephrol. 2005;9:40-5.
34. 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;60:62-73.