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ABOUT COVER

Peer Reviewer of *World Journal of Nephrology*, Amy Dwyer, MD, MS, FASN, FASDIN, Professor of Medicine, Director, Interventional Nephrology, University of Louisville, 615 South Preston Street, Louisville, KY 40202, United States. amy.dwyer@louisville.edu

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ORIGINAL ARTICLE

Retrospective Cohort Study

Bleeding complications after percutaneous kidney biopsies – nationwide experience from Brunei Darussalam

Chiao Yuen Lim, Sai Laung Khay

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Chiao Yuen Lim, Sai Laung Khay, Department of Renal Services, RIPAS Hospital, Bandar Seri Begawan BA1712, Brunei Darussalam

Corresponding author: Chiao Yuen Lim, FASN, FRCP, MBChB, MMed, MRCP, Consultant Physician-Scientist, Department of Renal Services, RIPAS Hospital, Jalan Putera Al-Muhtadee Billah, Bandar Seri Begawan BA1712, Brunei Darussalam. chiaoyuenlim905@gmail.com

Abstract

BACKGROUND

Kidney biopsy serves as a valuable method for both diagnosing and monitoring kidney conditions. Various studies have identified several risk factors associated with bleeding complications following the procedure, but these findings have shown inconsistency and variation.

AIM

To investigate the risk of bleeding complications following percutaneous kidney biopsy in Brunei Darussalam. We sought to explore the relevant clinical and pathological risk factors associated with these complications while also considering the findings within the broader international literature context.

METHODS

We conducted a retrospective study of all adult patients who underwent kidney biopsy in Brunei Darussalam from October 2013 to September 2020. The outcomes of interest were post-biopsy bleeding and the need for blood transfusions. Demographics, clinical, laboratory and procedural-related data were collected. Logistic regression analysis was used to identify predictors of outcomes.

RESULTS

A total of 255 kidney biopsies were included, with 11% being performed on transplanted kidneys. The majority of biopsies were done under ultrasound guidance (83.1%), with the rest under computer tomography guidance (16.9%). The most common indications for biopsy were chronic kidney disease of undefined cause (36.1%), nephrotic syndrome (24.3%) and acute kidney injury (11%). Rate of bleeding complication was 6.3% – 2% frank hematuria and 4.3% perinephric hematoma. Blood transfusion was required in 2.8% of patients. No patient lost a kidney or died because of the biopsy. Multivariate logistic regression identified baseline hemoglobin [odds ratio (OR): 4.11; 95% confidence interval (95%CI): 1.12-15.1; P = 0.03 for hemoglobin ≤ 11 g/dL *vs.* > 11 g/dL) and the

presence of microscopic hematuria (OR: 5.24; 95%CI: 1.43-19.1; P = 0.01) as independent risk factors for post-biopsy bleeding. Furthermore, low baseline platelet count was identified as the dominant risk factor for requiring post-biopsy transfusions. Specifically, each 10 10^9/L decrease in baseline platelet count was associated with an 12% increase risk of needing transfusion (OR: 0.88; 95%CI: 0.79-0.98; P = 0.02).

CONCLUSION
Kidney biopsies were generally well-tolerated. The identified risk factors for bleeding and transfusion can help clinicians to better identify patients who may be at increased risk for these outcomes and to provide appropriate monitoring and management.

Key Words: Kidney biopsy; Bleeding complications; Logistic regression; Retrospective cohort study; Risk

Core Tip: This retrospective study in Brunei Darussalam examined kidney biopsies from 2013 to 2020 and identified key risk factors for post-biopsy bleeding complications. Notably, it revealed that the presence of microscopic hematuria is a significant, previously unrecognized risk factor for such complications. Other findings included the impact of low baseline hemoglobin levels and platelet counts on bleeding and transfusion risk. These insights can assist clinicians in identifying high-risk patients and improving post-biopsy monitoring and care. Overall, the study enhances our understanding of kidney biopsy outcomes and patient safety.

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INTRODUCTION

A kidney biopsy is a procedure used to diagnose and monitor kidney disease. However, it is not without risks, with bleeding being a major complication due to its invasive nature. Bleeding complications can range from self-limited hematuria and asymptomatic perinephric hematomas, to life-threatening hemorrhage that can lead to serious consequences such as hemodynamic instability, kidney loss, and even death. In current practice, kidney biopsies are commonly performed percutaneously using real-time ultrasound guidance, which has been shown to decrease the risk of complications[1,2]. Moreover, automated spring-loaded biopsy devices have been found to be more effective than hand-driven systems, resulting in a higher yield of glomeruli and a reduction in major complications[3-5].

The frequency of complications following percutaneous native kidney biopsies varies across studies, mainly due to differences in patient populations, procedural techniques, complication definitions, and post-procedural monitoring. Although several risk factors for bleeding complications have been identified in different studies, the findings have been inconsistent[6]. A recent systematic review and meta-analysis that included 118064 biopsies reported that hematomas occurred in 11% of cases, frank hematuria in 3.5%, bleeding requiring blood transfusions in 1.6%, and interventions to stop bleeding in 0.3%[7].

In this study, we aimed to further investigate the risk of bleeding complications after percutaneous kidney biopsy and explore the associated clinical and pathologic risk factors. The study focused on a cohort of patients who underwent biopsies in Brunei Darussalam. By analyzing this specific group, the researchers aimed to provide more insights into the local context and shed light on factors that may contribute to bleeding complications.

MATERIALS AND METHODS

Study design and population

In this retrospective study, medical records of adult patients aged 18 years and above were reviewed over a period of seven years, from October 1, 2013, to September 30, 2020. The objective was to identify major bleeding complications associated with kidney biopsies. The analysis included only the first biopsy for patients who had multiple procedures. Kidney biopsy requests made by renal physicians were included, while those requested by urologists for investigating kidney lesions were excluded. Prior to the biopsy, informed consent was obtained from each patient. All antiplatelet and anticoagulation medications were stopped at least five days before the procedure, following the guidelines of the Society of Interventional Radiology[8]. Coagulation tests were performed a day before the biopsy, and if required, they were corrected using fresh frozen plasma or vitamin K to normalize the results. Pre-biopsy desmopressin was not administered. The biopsies were carried out in an inpatient setting, under local anesthesia, and with the guidance of

imaging techniques such as ultrasound or computed tomography (CT). In all cases, Bard Max-Core™ disposable core biopsy instrument with 18-gauge needles were used, typically performing 2 or 3 passes in the lower left renal pole, with the patient in the prone position. The decision on the number of passes was made by the procedurist based on whether sufficient core samples were obtained. After the procedure, patients were prescribed strict bed rest in a supine position for at least 6 h and monitored for post-procedure hematuria. Imaging was conducted immediately after the biopsy to confirm hemostasis, but further imaging to detect perinephric hematoma was only performed if clinically necessary. Perinephric hematoma was defined as the presence of hematoma on imaging that was over 1 cm in any dimension. Full blood counts were routinely performed the next day, and blood transfusions were given if clinically indicated. The decision to resume antiplatelet medications for patients at high cardiovascular risk was made on an individual basis, considering the risks and benefits. The study adhered to the ethical standards outlined in the Declaration of Helsinki and received approval from the institutional review board. A waiver of consent was granted by the Medical and Health Research and Ethics Committee.

Outcomes and covariates

Data on biopsy-associated bleeding events were collected by review of patient records. Outcomes of interest were post-biopsy bleeding (frank hematuria and/or perinephric hematoma), the need for blood transfusions, angiographic or open surgical interventions to control bleeding, nephrectomy and death. The timings of these bleeding events in relation to the procedure were also recorded.

Covariates examined included demographics (age, gender, ethnicity, height, weight), clinical (presence of hypertension, diabetes, whether dialysis was required before biopsy, biopsy indication), pre-biopsy laboratory (hemoglobin, platelet, serum creatinine, urea, albumin, total cholesterol, urine red blood cell, urine protein:creatinine ratio) and procedural-related (native or graft kidney, right or left kidney, procedurist, ultrasound or CT guided, number of passes, number of cores obtained) data.

Statistical analysis

mean ± SD were calculated for continuous parametric data, and medians and interquartile ranges for non-parametric data. Categorical data were reported using frequencies. For group comparisons, we used the Student *t*-test, Mann-Whitney test, chi-square test or Fisher exact test, as appropriate.

Logistic regression analysis was used to identify risk factors associated with the outcomes. Univariate analysis was done for each variable, using the Wald test. Any variable with a significant univariate test at P value < 0.1 was then selected as a candidate for the multivariate model along with all variables of known biologic importance. We chose this P value cut-off point as more traditional levels such as 0.05 can fail in identifying variables known to be important.

Following the fit of the multivariable model, iterative process of variable selection was done where covariates were removed from the model if they were non-significant and not a confounder. Significant was evaluated at the 0.05 alpha level and confounding as a change in any remaining parameter estimate greater than 15% as compared to the full model. At the end of this iterative process, the model contains significant covariates and confounders. Any variable not selected for the original multivariate model is added back one at a time, with significant covariates and confounders retained earlier. Any that are significant at the 0.05 level are put in the model, and the model is iteratively reduced as before but only for the variables that were additionally added.

All statistical analyses were performed using STATA software application version 17.

RESULTS

Over the 7-year period, 255 kidney biopsies were performed (Tables 1 and 2). The mean age of the patients were 35.5 years old, with mean weight of 72.3 kg. Out of the total, 28 procedures (11%) were conducted on transplanted kidneys. Notably, those performed with CT-guidance (16.9%) tended to involve patients with a higher average weight compared to those guided by ultrasound scan (83.1%) – with mean weights of 92 kg *vs.* 68 kg, respectively (P < 0.001). Forty-six percent of the patients had history of hypertension and 21% had history of diabetes. The primary reasons for performing biopsies were as follows: Chronic kidney disease of unspecified cause (36%), nephrotic syndrome (24%), and acute kidney injury (AKI) (11%). 10.2% of patients needed dialysis pre-biopsy. This decision was left at the discretion of the attending nephrologists. The median pre-biopsy serum creatinine was 158 [interquartile range (IQR): 80 to 381] μmol/L, hemoglobin 11.5 ± 2.6 g/dL and platelet count 300 ± 108.3 10^9/L. Out of the 255 kidney biopsies performed, only 5 patients exhibited minor abnormalities in their coagulation tests prior to the procedure. This 2% incidence was deemed statistically insignificant. Importantly, none of these 5 patients experienced any bleeding complications post-biopsy. Consequently, our team decided not to incorporate coagulation tests as predictive factors. Moreover, it is worth noting that the occurrence of post-biopsy bleeding could not be linked to abnormal coagulation test results, as all patients involved in this study displayed normal coagulation results or had their abnormalities corrected before the biopsy. The mean size of the biopsied kidney was 11 ± 1.4 cm. Majority (92.4%) needed two passes.

Bleeding complications were observed in 16 (6.3%) patients, with 4.3% developing a perinephric hematoma and 2% experiencing frank hematuria. These bleeding complications happened at a median of 1-hour (IQR: 1-15 h) post-biopsy. The maximum duration was a 48 h delay. Blood transfusion was needed in a total of 7 (2.8%) patients. As shown in Tables 3 and 4, both bleeding complications and need for blood transfusion were associated with very similar risk factors in the univariate analysis – the presence of microscopic hematuria, 4 needle passes (compared to 2 passes), lower baseline hemoglobin, platelet, complements, higher serum creatinine, urea, as well as anti-double stranded DNA and antinuclear

Table 1 Characteristics of study cohort (continuous variables)

Variables	*N* = 255	Missing
Mean age in years	35.5 ± 14.3	
Mean weight (kg)	72.3 ± 20.1	21
Mean hemoglobin (g/dL)	11.5 ± 2.6	1
Mean platelet (× 10^9/L)	300 ± 108.3	1
Median creatinine (μmol/L)	158 (80-381)	
Median urea (mmol/L)	9.4 (5.5-15.8)	
Mean albumin (g/L)	30.1 ± 9.1	
Median cholesterol (mmol/L)	5.6 (4.6-8.2)	13
Median urine protein: Creatinine ratio (mg/mmol)	598 (239-1119)	20
Median 24hr urine total protein (g/day)	4.2 (1.7-7.8)	103
Mean complement C3 (g/L)	1 ± 0.4	43
Mean complement C4 (g/L)	0.28 ± 0.14	44
Mean size of biopsied kidney (cm)	11 ± 1.4	40

Table 2 Characteristics of study cohort (categorical variables)

Variables	Classifications	*N* = 255	Missing
Male gender		120 (47%)	
Ethnicity	Malay	207 (81.2%)	
	Chinese	6 (2.4%)	
	Indian	1 (0.4%)	
	Other	41 (16%)	
Presence of hypertension		116 (45.5%)	
Presence of diabetes		53 (20.8%)	
Dialysis before biopsy		26 (10.2%)	
Clinical syndrome	Isolated hematuria	4 (1.6%)	
	Isolated non-nephrotic proteinuria	25 (9.8%)	
	Hemo-proteinuria	26 (10.2%)	
	Nephritic syndrome	2 (0.8%)	
	RPGN	1 (0.4%)	
	Nephrotic syndrome	62 (24.3%)	
	Nephritic-nephrotic syndrome	10 (3.9%)	
	AKI	28 (11%)	
	CKD of undefined cause	92 (36.1%)	
	Other	5 (2%)	
Presence of urine RBC		108 (43.9%)	9
Presence of ANA		69 (29.5%)	31
Presence of anti-dsDNA		28 (15.5%)	74
Presence of ENA		28 (15.6%)	76
Presence of ANCA		8 (4.2%)	63
Presence of HBV		6 (2.6%)	27

Presence of HCV		2 (0.9%)	34
Presence of HIV		2 (1%)	45
Transplanted (*vs*. native) kidney		28 (11%)	
If native, right (*vs*. left) kidney		3 (1.3%)	
Procedurist	Radiologist 1	82 (34%)	15
	Radiologist 2	28 (11.6%)	
	Radiologist 3	68 (28.2%)	
	Radiologist 4	13 (5.4%)	
	Radiologist 5	49 (20.3%)	
	Radiologist 6	1 (0.4%)	
CT (*vs*. USS) guidance		43 (16.9%)	
Number of passes	1	1 (0.5%)	57
	2	183 (92.4%)	
	3	11 (5.6%)	
	4	3 (1.5%)	
Number of cores	1	3 (1.5%)	48
	2	188 (90.8%)	
	3	12 (5.8%)	
	4	4 (1.9%)	

RPGN: Rapidly progressive glomerulonephritis; AKI: Acute kidney injury; CKD: Chronic kidney disease; RBC: Red blood cell; ANA: Antinuclear antibody; Anti-dsDNA: Anti-double stranded DNA; ENA: Extractable nuclear antigen antibodies; ANCA: Antineutrophil cytoplasmic antibodies; HBV: Hepatitis B virus; HCV: Hepatitis C virus; HIV: Human Immunodeficiency virus; CT: Computer tomography; USS: Ultrasound scan.

antibodies positivity.

Multivariable logistic regressions were performed to assess factors associated with an increased risk of bleeding complications and the need for blood transfusion after kidney biopsy. As indicated in Table 3, there is a significant association between pre-biopsy hemoglobin levels [with an odds ratio (OR) of 4.11; 95% confidence interval (95%CI): 1.12-15.1; P = 0.03 for hemoglobin 11 g/dL *vs*. >11 g/dL) and the presence of microscopic hematuria (with an OR of 5.24; 95%CI: 1.43–19.1; P = 0.01), both linked to the occurrence of post-biopsy bleeding.

After adjustment for other variables, it was solely the pre-biopsy platelet level that emerged as the primary factor influencing the need for post-biopsy blood transfusions. For every decrease of 10000/μL in the initial platelet count, there was a corresponding 12% rise in the likelihood of requiring a blood transfusion (with an OR of 0.88; 95%CI: 0.79-0.98; P = 0.02). There was no death, nephrectomy or angiographic or open surgical interventions needed to control bleeding. No differences in outcomes were found regarding the biopsy time period, first period from 2013 to 2016 years and second period from 2017 to 2020 (data not shown).

DISCUSSION

Our study has provided further evidence of the safety of kidney biopsy. We did not observe any nephrectomy or death after kidney biopsies performed in these 7 years. In a large meta-analysis, the rate of nephrectomy and death were 0.01% and 0.02% respectively[9].

The incidence of bleeding complications, specifically perinephric hematoma and frank hematuria, was found to be similar to that reported in other studies such as by Pombas *et al*[10] (5.44% hematoma, 2.57% frank hematuria) and Xu *et al*[11] (5.8% hematoma, 4.8% frank hematuria). However, two meta-analyses conducted by Poggio *et al*[7] and Corapi *et al*[9] have reported a higher incidence of hematoma at 11% and 11.6% respectively, while the incidence of frank hematuria was found to be comparable at 3.5% in both meta-analyses.

In our study, the 2.8% incidence of blood transfusion after kidney biopsy is consistent with the findings of other studies such as Shidham *et al*[12] (2.48%). However, our rate is lower compared to some population-based studies from other countries such as United States (26%)[13], Canada (9%)[14], France (5%)[15], Boston (4.3%)[16] and Australia (4%)[17]. Some of these population-based studies overestimated the risks of blood transfusion as not all of the events were attributable to kidney biopsies, particularly if the cohort had high co-morbidities such as anemia and heart failure. On the other hand, our rate of blood transfusion is higher than some other studies, such as Poggio *et al*[7] (1.6%), Pombas *et al*[10] (1.2%), Andrulli *et al*[18] (1.1%), Corapi *et al*[9] (0.9%), Tøndel *et al*[19] (0.9%) and Kawaguchi *et al*[20] (0.8%).

Table 3 Odds ratios for bleeding complications

Variables	Classifications	Univariate logistic regression			Multivariate logistic regression[1]		
		OR	95%CI	*P* value	OR	95%CI	*P* value
Age (yr)		1.02	0.99-1.06	0.254			
Gender	Female	Reference					
	Male	0.49	0.17-1.47	0.204			
Ethnicity	Malay	Reference					
	Chinese	2.55	0.28-23.2	0.407			
	Indian	NA	NA	NA			
	Other	NA	NA	NA			
Mean weight (kg)		1.01	0.98-1.04	0.428			
Hypertension	No	Reference					
	Yes	1.2	0.44-3.31	0.720			
Diabetes	No	Reference					
	Yes	1.8	0.60-5.42	0.297			
Dialysis before biopsy	No	Reference					
	Yes	2.16	0.57-8.13	0.256			
Clinical syndrome	AKI	Reference					
	Isolated hematuria	NA	NA	NA			
	Isolated non-nephrotic proteinuria	NA	NA	NA			
	Hemo-proteinuria	0.33	0.03-3.43	0.355			
	Nephritic syndrome	NA	NA	NA			
	RPGN	NA	NA	NA			
	Nephrotic syndrome	0.28	0.04-1.80	0.180			
	Nephritic-nephrotic syndrome	NA	NA	NA			
	CKD of undefined cause	1.02	0.26-3.98	0.982			
	Other	NA	NA	NA			
Mean hemoglobin (g/dL)	> 11	Reference			Reference		
	≤ 11	5.04	1.40-18.15	0.013[2]	4.11	1.12-15.1	0.033
Mean platelet (× 10^9/L)	> 250	Reference					
	≤ 250	3.23	1.13-9.20	0.028[2]			
Median creatinine (μmol/L)	< 265	Reference					
	≥ 265	3.62	1.27-10.3	0.016[2]			
Median urea (mmol/L)	< 10	Reference					
	≥ 10	3.8	1.19-12.12	0.024[2]			
Mean albumin (g/L)		0.95	0.90-1.01	0.080[2]			
Median cholesterol (mmol/L)		0.91	0.75-1.11	0.346			
Presence of urine RBC	No	Reference			Reference		
	Yes	6.1	1.7-22	0.006[2]	5.24	1.43-19.1	0.012
Median urine protein:creatinine ratio (mg/mmol)		1	0.9996-1.0005	0.787			

Median 24 h urine total protein (g/day)		0.92	0.78-1.09	0.351
Mean complement C3 (g/L)	≥ 0.8	Reference		
	< 0.8	3.35	1.20-9.36	0.021[2]
Mean complement C4 (g/L)	≥ 0.15	Reference		
	< 0.15	3.41	1.10-10.5	0.033[2]
Presence of ANA	No	Reference		
	Yes	2.98	1.03-8.58	0.044[2]
Presence of anti-dsDNA	No	Reference		
	Yes	3.94	1.19-13.1	0.025[2]
Presence of ENA	No	Reference		
	Yes	1.89	0.48-7.48	0.363
Presence of ANCA		NA	NA	NA
Presence of HBV		NA	NA	NA
Presence of HCV		NA	NA	NA
Presence of HIV		NA	NA	NA
Kidney type	Native	Reference		
	Transplanted	0.52	0.07-4.10	0.536
Site of kidney		NA	NA	NA
Mean size of biopsied kidney (cm)	> 12	Reference		
	≤ 12	2.11	0.58-7.63	0.254
Procedurist	Radiologist 1	Reference		
	Radiologist 2	0.30	0.04-2.48	0.265
	Radiologist 3	0.51	0.15-1.73	0.277
	Radiologist 4	0.68	0.08-5.83	0.722
	Radiologist 5	0.17	0.02-1.38	0.101
	Radiologist 6	NA	NA	NA
Guidance	Ultrasound	Reference		
	CT	2.39	0.79-7.28	0.124
Number of passes	1	NA	NA	NA
	2	Reference		
	3	NA	NA	NA
	4	8.65	0.72-103.7	0.089[2]
Number of cores	1	35.6	2.97-426.6	0.005[2]
	2	Reference		
	3	NA	NA	NA
	4	5.93	0.57-62.3	0.138

[1]Only *P* value < 0.05 in the multivariate analysis is shown.
[2]*P* value < 0.1.
OR: Odds ratio; 95%CI: 95% confidence interval; NA: Not applicable (as zero cell count); AKI: Acute kidney injury; RPGN: Rapidly progressive glomerulonephritis; CKD: Chronic kidney disease; RBC: Red blood cell; ANA: Antinuclear antibody; Anti-dsDNA: Anti-double stranded DNA; ENA: Extractable nuclear antigen antibodies; ANCA: Antineutrophil cytoplasmic antibodies; HBV: Hepatitis B virus; HCV: Hepatitis C virus; HIV: Human Immunodeficiency virus; CT: Computer tomography.

Table 4 Odds ratios for blood transfusion

Variables	Classifications	Univariate logistic regression			Multivariate logistic regression[1]		
		OR	95%CI	*P* value	OR	95%CI	*P* value
Age (yr)		1.00	0.95-1.05	0.951			
Gender	Female	Reference					
	Male	0.44	0.08-2.33	0.338			
Ethnicity	Malay	Reference					
	Chinese	NA	NA	NA			
	Indian	NA	NA	NA			
	Other	NA	NA	NA			
Mean weight (kg)		0.99	0.95-1.04	0.809			
Hypertension	No	Reference					
	Yes	0.89	0.19-4.06	0.880			
Diabetes	No	Reference					
	Yes	0.63	0.07-5.31	0.667			
Dialysis before biopsy	No	Reference					
	Yes	NA	NA	NA			
Clinical syndrome	AKI	Reference					
	Isolated hematuria	NA	NA	NA			
	Isolated non-nephrotic proteinuria	NA	NA	NA			
	Hemo-proteinuria	NA	NA	NA			
	Nephritic syndrome	NA	NA	NA			
	RPGN	NA	NA	NA			
	Nephrotic syndrome	0.45	0.03-7.47	0.577			
	Nephritic-nephrotic syndrome	NA	NA	NA			
	CKD of undefined cause	1.55	0.17-13.9	0.694			
	Other	NA	NA	NA			
Mean hemoglobin (g/dL)	> 11	Reference					
	≤ 11	6.67	0.79-56.2	0.081[2]			
Mean platelet (10×10^9/L)		0.88	0.79-0.98	0.021[2]	0.88	0.79-0.98	0.021
Median creatinine (μmol/L)		1.001	0.999-1.003	0.105			
Median urea (mmol/L)		1.068	0.999-1.141	0.052[2]			
Mean albumin (g/L)		0.93	0.86-1.01	0.105			
Median cholesterol (mmol/L)		0.94	0.71-1.24	0.654			
Presence of urine RBC	No	Reference					
	Yes	8	0.95-67.5	0.056[2]			
Median urine protein:creatinine ratio (mg/mmol)		1	0.9997-1.0006	0.415			
Median 24 h urine total protein (g/day)		0.88	0.66-1.18	0.389			
Mean complement C3 (g/L)	≥ 0.8	Reference					

	< 0.8	6.32	1.20-33.3	0.030[2]
Mean complement C4 (g/L)	≥ 0.15	Reference		
	< 0.15	5.43	1.16-25.4	0.032[2]
Presence of ANA	No	Reference		
	Yes	6.39	1.21-33.8	0.029[2]
Presence of anti-dsDNA	No	Reference		
	Yes	12.6	2.18-72.5	0.005[2]
Presence of ENA	No	Reference		
	Yes	2.83	0.49-16.2	0.244
Presence of ANCA		NA	NA	NA
Presence of HBV		NA	NA	NA
Presence of HCV		NA	NA	NA
Presence of HIV		NA	NA	NA
Kidney type	Native	Reference		
	Transplanted	1.36	0.16-11.7	0.781
Site of kidney		NA	NA	NA
Mean size of biopsied kidney (cm)	> 12	Reference		
	≤ 12	1.18	0.22-6.19	0.849
Procedurist	Radiologist 1	Reference		
	Radiologist 2	NA	NA	NA
	Radiologist 3	0.79	0.13-4.86	0.797
	Radiologist 4	2.17	0.21-22.6	0.518
	Radiologist 5	0.54	0.05-5.36	0.600
	Radiologist 6	NA	NA	NA
Guidance	Ultrasound	Reference		
	CT	0.81	0.10-6.93	0.850
Number of passes	1	NA	NA	NA
	2	Reference		
	3	NA	NA	NA
	4	22.4	1.67-300.3	0.019[2]
Number of cores	1	23	1.71-308.7	0.018[2]
	2	Reference		
	3	NA	NA	NA
	4	15.3	1.30-181.4	0.030[2]

[1]Only p-value < 0.05 in the multivariate analysis is shown.
[2]*p*-value < 0.1.
OR: Odds ratio; 95%CI: 95%confidence interval; NA: Not applicable (as zero cell count); AKI: Acute kidney injury; RPGN: Rapidly progressive glomerulonephritis; CKD: Chronic kidney disease; RBC: Red blood cell; ANA: Antinuclear antibody; Anti-dsDNA: Anti-double stranded DNA; ENA: Extractable nuclear antigen antibodies; ANCA: Antineutrophil cytoplasmic antibodies; HBV: Hepatitis B virus; HCV: Hepatitis C virus; HIV: Human Immunodeficiency virus; CT: Computer tomography.

Our study found that patients with low baseline hemoglobin were more likely to experience bleeding complications, while those with low baseline platelet counts had an increased risk of requiring blood transfusion. This is consistent with findings from other studies, such as Pombas *et al*[10] and Xu *et al*[11]. Specifically, we observed that with every decrease of 10000/μL in the initial platelet count, there was a corresponding 12% rise in the likelihood of necessitating a blood transfusion. This is comparable to the 11% increase reported in the Xu *et al*[11] study.

To our knowledge, our study is the first to show that the presence of microscopic hematuria is associated with bleeding complication following kidney biopsy. The reasons for this association are unclear, and it is possible that unmeasured confounding factors may contribute to both hematuria from glomerular bleeding and bleeding post-biopsy. Therefore, further evaluation in larger, prospective studies is needed before changes are made to clinical practice. Interestingly, a recent study by Andrulli *et al*[18] found that high proteinuria levels may actually protect against bleeding complications after biopsy. It is therefore important that variables including urinalysis (hematuria and/or proteinuria) be included in the regression models in future studies, to better elucidate this association.

Numerous studies have reported increased bleeding complications and the need for blood transfusions to be associated with factors such as presence of hypertension[12,21], presence of diabetes[22], poor kidney function[9,18,23,24], female [17,25,26], elderly[9,27], larger biopsy needle[9,28], higher number of needle passes[18], AKI as indication for biopsy[7,9,11,26]. We have not found these variables to be significant risk factors in our cohort. It is important to note that different studies may use different definitions of bleeding complications, have variation in patient selection, procedural technique or monitoring protocols, leading to variability in findings. Analyses of predictors of complications associated with kidney biopsy also vary across studies.

Our study found that majority of bleeding complications were identified within the first 1-15 h of the biopsy, but a significant proportion (2%-10%) occurred after 24 h[12,14,29]. Specifically, we observed that 6% of patients with bleeding complications experienced them after 24 h. Therefore, it is crucial to consider the appropriate post-biopsy observation period based on individual patient risk.

A strength of our study is the nationwide investigation that allowed for an extensive and in-depth analysis of risk factors for post-biopsy bleeding complications in the current era. However, our study has some limitations that should be considered. Our findings are limited by the relatively small sample size which may limit the power to detect significant associations. Residual confounding is also likely to be present in the retrospective study design. Additionally, we did not collect data on certain potential predictors, such as blood pressure and coagulation tests. We also did not evaluate the impact of antiplatelet use as it is already standard practice to withhold. Furthermore, a recent meta-analysis found no significantly increased risk for major bleeding complications in patients on aspirin[30]. Another limitation is that repeat imaging post-biopsy was not routinely performed, unless prompted by patient symptoms or hemodynamic instability. This may have led to ascertainment bias and potential underestimation of hematoma events.

Notwithstanding these limitations, the identified risk factors can still be utilized in clinical practice to effectively risk stratify patients and inform shared-decision making. Counseling patients on these known risks is imperative to achieving patient-centered care. We strongly suggest that modifiable risk factors be managed aggressively to lower the risk of bleeding.

CONCLUSION

In conclusion, our study shows that the risk of bleeding after kidney biopsy performed by radiologists is generally low. However, we found that bleeding complications were more frequent in patients with lower pre-biopsy hemoglobin level and those with microscopic hematuria. Patients with lower platelet counts also had a higher likelihood of requiring blood transfusion after kidney biopsy. While our findings support the safety of kidney biopsy, it is important to carefully evaluate patients in order to minimize the risks associated with the procedure.

ARTICLE HIGHLIGHTS

Research background

Kidney biopsy serves as a valuable method for both diagnosing and monitoring kidney conditions. However, various studies have identified several risk factors associated with bleeding complications following the procedure, but these findings have shown inconsistency and variation.

Research motivation

Identifying key factors that significantly predict complications following a kidney biopsy is valuable in providing patients with essential information when seeking their consent for the procedure.

Research objectives

Our primary objective was to investigate the risk of bleeding complications following percutaneous kidney biopsy in Brunei Darussalam. We sought to explore the relevant clinical and pathological risk factors associated with these complications while also considering the findings within the broader international literature context.

Research methods

We performed a retrospective review of records of patients who underwent percutaneous kidney biopsies in Brunei Darussalam from October 1, 2013 to September 30, 2020. The demographic, clinical, laboratory and procedural-related characteristics of the patients were reviewed.

Research results

A total of 255 kidney biopsies were included. The incidence of bleeding (including hematuria and perinephric hematoma) stood at 6.3%. Blood transfusions were deemed necessary for 2.8% of patients, and fortunately, no patient suffered kidney loss or mortality due to the biopsy procedure. In a multivariable logistic regression analysis, two factors emerged as independent risk contributors for post-biopsy bleeding: baseline hemoglobin levels and the presence of microscopic hematuria. Additionally, a lower baseline platelet count emerged as the primary risk factor associated with the need for post-biopsy transfusions.

Research conclusions

Our findings align with existing research regarding the predictive risk factors for post-kidney biopsy bleeding complications. Nevertheless, our study uniquely highlights that the presence of pre-biopsy microscopic hematuria represents a notable and previously unreported risk factor for these complications.

Research perspectives

While our findings support the safety of kidney biopsy, it is important to carefully evaluate patients in order to minimize the risks associated with the procedure.

FOOTNOTES

Author contributions: Lim CY designed the research, contributed to the statistical analysis, literature review, writing and revision; Khay SL collected the data and contributed to the writing and revision; all authors approved the paper.

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Country/Territory of origin: Brunei Darussalam

ORCID number: Chiao Yuen Lim 0000-0001-8471-8383; Sai Laung Khay 0009-0001-4103-7497.

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