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Incidence and Determinants of Complications of Percutaneous Kidney Biopsy in a Large Cohort of Native Kidney and Kidney Transplant Recipients

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Abstract

Objectives: Percutaneous kidney biopsy is a useful diagnostic procedure. Hemorrhagic complications may occur following the procedure. ***Methods:*** We retrospectively analyzed the records of 1198 patients who had percutaneous renal biopsy between March 2013 and March 2018. The cohort included both native kidney and transplant biopsies. We have included only the first biopsy for each patient; repeat biopsies for 132 patients were excluded from the analysis. ***Results:*** 1198 patients (332 transplant recipients and 886 native kidney patients) were included in the study. Major complications occurred in 18(1.5%) of patients (1.4% in native kidney biopsies Vs 1.6% in kidney transplant recipients. Adequate renal tissue (core of > 6 glomeruli) was obtained in 91 % of patients. Our analysis revealed that the incidence of major complications, in the native kidney biopsy are increased with age>65 years (odds ratio2.4, 95 % CI (1.5-5.6), eGFR<30 ml/min/m^2 (odds ratio 9.7, 95 % CI (3.4-18.2)) and anemia(9-11 mg/dl)(odds ratio3.2 (1.7-5.2), 95 % CI(1.7-5.2). In transplant recipients kidney biopsy the incidence of complications was increased with age>65 years (odds ratio 2.8(1.7-7.3), 95 % CI (1.7-7.3), eGFR<30 ml/min/m^2 (odds ratio 11.3, 95 % CI (3.5-16.8) and anemia (9-11mg/dl)(odds ratio 2.4, 95 %(1.7-4.7). ***Conclusion:*** The incidence of major complications following

kidney biopsy was 1,5%(for a cohort of native kidney biopsy and kidney transplant biopsies . Age> 65 years, lower eGFR < <30 ml/min/m^2 and anemia were independent risk predictors for the occurrence of major complications in both native and transplant kidney biopsy.
Keywords: Biopsy; biopsy, needle; renal, complications, safety, adequacy.

Advances in Knowledge

- The incidence of major complications of percutaneous kidney biopsy is low (1.5%) in our cohort.
- There are a number of factors that predict safety of kidney biopsy most importantly age, estimated glomerular filtration(eGFR) rate and anemia.

Application to Patient Care

- Some factors should be taken into consideration while deciding on kidney biopsy to maximize safety.
- Some factors are correctable (anemia) and some other factors are not correctable (age and eGFR).

Introduction

Renal biopsy is a procedure that has been in practice for more than 100 years [1]. The technique has seen substantial evolution since the introduction of percutaneous renal biopsy in 1940s [23]. The main aim of technique and needle development is to increase diagnostic yield, meanwhile, decreasing the rate of complications.

Percutaneous approach to obtain the kidney tissue is now considered the standard of care. The technique involves obtaining the biopsy sample using ultrasound guidance, under local anesthesia. The needles that are used during the procedure have variable gauges: 14, 16 and 18, the outer diameter of which are 2.11, 1.65, and 1.27 mm, respectively). Spring- loaded automatic needles have almost replaced the older true cut needles in most centres. A number of studies have suggested the superiority of automatic needles over Tru-Cut® needles in obtaining adequate renal tissue while decreasing the rate of complications. Thus, automatic spring-loaded needles have been the standard of care in most centres [4].

Various major complications may occur after percutaneous renal biopsy procedure. Those include massive bleeding requiring red blood cells (RBCs transfusion), the requirement of angiographic embolization to control the bleeding, nephrectomy or death. The incidence of major complications in native kidney biopsies is 2-8% as reported in the literature [5]. Other less serious compilations include renal hematoma following renal biopsy and macroscopic hematuria.

A satisfactory diagnostic yield is achieved in 90-95% of the cases with the use of automatic needles; obtaining 10-20 glomeruli is usually sufficient to make a pathological diagnosis.

Methods

The records of the renal division of Kasr-Alainy university hospitals were reviewed. The investigators have reviewed all the records that were available regarding patients who had undergone renal biopsy between March 2013 and March 2018. The renal division in Kasr-Alainy center is a large tertiary care center; percutaneous renal biopsies are performed on regular weekly slots. All biopsies were performed using ultrasound guidance. The cohort included both native and kidney transplant recipients. We have included only the first biopsy for each patient; repeat biopsies for 132 patients were excluded from the analysis.The recorded data include epidemiological data: age, sex, eGFR, hemoglobin level, needle gauge and style. In our center, it is contraindicated to perform kidney biopsy to patients with platelets < 100.000/ cc or INR > 1.00. It is also contraindicated to perform kidney biopsy with hemoglobin < 9 mg/dl as per our protocol. Any uncorrected bleeding diathesis was considered a contraindication for renal biopsy

Desmopresin (DDAVP) is not routinely used as a premedication in kidney biopsies as per our protocol. All patients were required to stop anti-platelets one week before renal biopsy. Patients on oral anticoagulants were required to be switched to unfractionated heparin which was held at least 12 hours before attempting renal biopsy. Kidney biopsies were all performed by one operator, MF who is the main author of this paper. To make analysis less complex, each patient had only one entry into the study.

Ethical considerations

The research was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all the patients. This study protocol was approved by the Kasr-Alainy Research Ethics Committee(KA-REC)

Statistical analysis

SPSS version 21 was used to obtain the statistical analysis. Categorical variables were compared using Chi square test. Continuous variables were expressed as mean and standard deviation. The group means were compared using Mann Whitney U test. Logistic regression was used to create a model to predict the development of major complications of percutaneous renal biopsy. A forward stepwise method was used in the binary logistic regression.

Results

We have reviewed the records if 1198 patients who have undergone renal biopsy during the prespecified period. The rate of major complications was the same as the rate in our cohort. We can conclude that this was not a source of serious bias. What has been included in the analysis was only the first biopsy of every patient.

Baseline patients' characteristics

Table (1) shows baseline patients characteristics of both native and transplant recipient kidney biopsies.

Adequacy of renal biopsy

The biopsy is considered adequate and representative if 6-10 glomeruli were obtained successfully. The overall diagnostic yield of the needles, of different gauges are shown in figure (1).

Gross hematuria

Macroscopic hematuria occurred in 2.8% of patients (n=34). The occurrence of macroscopic hematuria was significantly higher with the use of 14 G needles. Table (2) shows gross hematuria by needle gauge.

Major complications

Major complications were defined as either the need for blood transfusion or the need for surgical procedure/ angiographic embolization to stop the bleeding following the biopsy procedure. Table (3) shows breakdown of major complications for native and kidney transplant recipients respectively. Table (4) and Table (5) show predictors of occurrence of major complications following renal biopsy in native kidney biopsy and transplant respectively. The variables were adjusted for age and age was adjusted for eGFR. One hundred and thirty two patients had more than one renal biopsy; repeat biopsies have not been included in the analysis. 2 patients (1.5%) had major complications.

Discussion

Our study cohort includes 1198 patients who underwent percutaneous renal biopsy; this included 332 transplant recipients and 886 native kidney patients. Major complications, defined as either the need for blood transfusion , the need for surgery or need for arterial embolisation, occurred in 1.5% of patients. Gross hematuria occurred only in 2.8% of patients. This emphasizes the overall safety of the percutaneous renal biopsy procedure, a finding that has been demonstrated by previous reports [6,7]. Adequate renal tissue was obtained in 91 % of patients. There were a number of factors that predicted the development of complications. Age > 65 ,eGFR < 30 ml/kg/min and anemia < 9 mg/ dl were associated with increased odds of developing major complications.. The incidence of major complications was not statistically significant among different needle gauges. the use of either 14 G or 16 G was associated with more adequate renal tissue and this was statistically significant.Our study is one of the largest reports of kidney biopsy safety and complications in the a cohort of both native kidneys and kidney transplant recipients.

Complications after the procedure of percutaneous renal biopsy range from the observation of peri-nephric hematomas which have an incidence of 60-70% in previous reports. Nevertheless, on most occasions peri-nephric hematomas are not clinically meaningful and thus should not be regarding as an alarming complication [8]. There are a number of other hemorrhagic complications which include macroscopic hematuria, major bleeding requiring surgery or angiographic embolization. A number of factors have been suggested to be associated with the potential

hemorrhagic complications. These factors could be divided into procedure related factors and patient related factors. patient related factors include age more than 40 years, female sex, elevated serum creatinine and lower hemoglobin level at the time of the procedure [5,910]. The important procedure related factor was the use of 14 G needles. Interestingly, it was observed that the increased number of passes due to the use of smaller diameter needles did not lead to increased hemorrhagic complications [1112].

Many previous studies have found that the complications rates were lower with the use of small diameter biopsy needles [1314615]. In a nationwide registry in Norway, the incidence of major complications was found to be 0.9 % [16]. In this study, the incidence of major complications was not affected by needle gauge; however, the use of 18 G was associated with the occurrence of more frequent gross hematuria. The explanation for this observation was that the small gauge needles allow the easy deviation of the needle towards the high density vessels in the pelvis. In another small cohort of 86 patients, the use of 14 G needles were associated with more frequent hematoma following the procedure of percutaneous renal biopsy[17].

A large meta-analysis of more than 9000 patients who underwent percutaneous native kidney biopsy found that the use of 14 G needles was associated with higher incidence of requirement of packed RBCs transfusion [5].The incidence of hemorrhagic complications, as reported in this meta-analysis was: macroscopic hematuria in 3.5%, the requirement for packed red blood cell transfusion in 0.9 %. Anemia is another important predisposing factor for the occurrence of post procedure hemorrhagic complications. This has been evident in previous reports.

Data on kidney transplant biopsy complications stratified by needle gauge is scarce. However, one prospective randomized trial found that there was no statistically significant difference between the three needle diameters (14G, 16G and 18 G) as regard the incidence of major complications. The use of 14 G was associated with more pain [18]. The study was limited by the small sample size; our study cohort provides a larger sample of transplant patients.

Our study is one of the largest analyses to stratify the complications of percutaneous renal biopsies. One of the strengths of our study is that our cohort includes both native and renal transplant recipient patients. Different needle gauges are well represented in the sample.

The study has a number of limitations. Firstly, we could not ascertain the number of needle passes for each biopsy. Secondly, this is a single centered study; a multi-centered study would provide more data about the difference in operators' expertise. Thirdly, the incidence of post-biopsy renal hematoma was not reported in our study as the records did not provide sufficient data to include this complication in the analysis. Fourthly, the study protocol specifies recording only the first biopsy for every patient. This is closely comparable to the rate of major complications in the main cohort. We therefore do not count this as a major source of bias.

Conclusion

The incidence of major complications following kidney biopsy was 1,5%(for a cohort of native kidney biopsy and . Age> 65 years, lower eGFR **<30 ml/min/m^2** and anemia ,were independent risk predictors for the occurrence of major complications in both native and transplant kidney biopsy.

Conflicts of interest

The authors declared that no conflict of interest.

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Table 1: Baseline patients characteristics at the time of kidney Biopsy

	Native kidney	Transplant recepient	*P Value
Age(years) mean(SD)	48±17	45±14	0.24
Sex(%) male	61	60	0.31
Nephrotic range protenuria ≥ 3 gm(%)	35%	31%	0.03
AKI	30%	27%	0.04
Hematuria	61%	57%	0.02
protenuria ≥ 0.3 gm(%)	84%	79%	0.001

*Chi-squared test

Table 2: Gross hematuria by needle gauge

		Gross-hematuria		**Total**	***P* value**
		No	**yes**		
Needle-gauge	**14**	277	16	293	**0.008**
	16	445	9	454	
	18	442	9	451	
Total		1164	34	1198	
***Kruskal-Wallis test**					

Table 3: Incidence of complications (native Vs transplant recipient)

Complication	**Total (1198)**	**native (886)**	**Transplant recipients (312)**	***P value***
Gross hematuria(%)	34(2.8)	25(2.8%)	9(3%)	0.1
Major complications	18(1.5%)	13(1.46)	5(1.6%)	0.15

surgery	4(0.3%)	3	1(0.3)	0.91
Arterial embolisation	3(0.2)	2	1(0.3)	0.54
Need for PRBCS transfusion	16(1.3)	12(1.3%)	4(1.2)	0.23

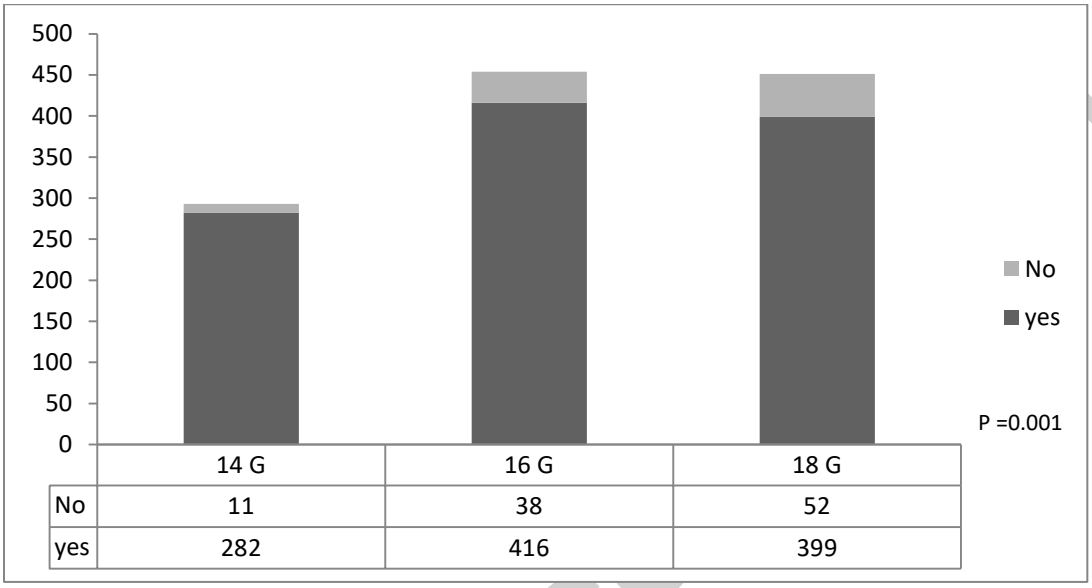

Figure 1: Adequacy of renal tissue by needle gauge

Table 4: Predictors of occurrence of major complications in native kidney biopsy

	Unadjusted analysis		**Adjusted analysis**	
	Odds Ratio (CI)	***P* value**	**Odds Ratio (CI)**	***P* value**
Age (years)				
18-65	1.00 (reference)		1.00 (reference)	
> 65	2.7(1.7-5.7)	<0.001	2.4(1.5-5.6)	<0.001
Sex				
Male	1.15(0.97-1.9)	0.71	1.1(0.9-1.7)	0.64
Female	1.00(reference		1.00 (reference)	
eGFR (ml/min per 1.73)				
≥60	1.00(reference)		1.00(reference)	<0.001
30-59	4.7(1.6-12.1)	<0.001	4.5(2.3-13.4)	
<30	11.1(2.6-17.1)		9.7(3.4-18.2)	

proteinuria (g/24 hour)					
< 3		1.00 (reference)	0.61	1.00 (reference)	0.54
≥ 3		1.5(0.9-3.9)		1.3(0.9-2.7)	
Needle gauge					
	14	1.5(0.87-2.7)		1.3(0.85-2.1)	
	16	1.4(0.9-2.1)	0.53	1.1(0.7-1.9)	0.73
	18	1.00 reference		1.00 reference	
Hemoglobin (mg/dl)					
>13		1.00(reference)		1.00(reference)	
11-13		1.8(1.5-5.9)	0.003	2.39(1.5-4.5)	0.003
9-11		2.65(1.8-6.4)		3.2 (1.7-5.2)	
Platelets(per cubic cm)					
>150.000		1.00 reference	0.47	1.00 reference	0.56
100.000-150.000		1.6(0.9-2.3)		1.5(0.9-2.6)	
AKI					
Yes		2.30(0.7-3.6)	0.37	1.9(0.8-5.5)	0.46
No		1.00 reference		1.00 reference	
Glomerulonephritis					
yes		1.02 (0.9-2.4)	0.25	1.03(0.9-2.6)	0.29
No		1.00 reference		1.00 reference	
Pre-biopsy blood pressure (mmHg)					
< 140		1.00(reference)		1.00 reference	
140-159		1.24(0.7-6.03)	0.79	1.2(0.31-5.6)	0.81
≥ 160		2.84(0.8-9.9)		2.3(0.55-8.6)	
Referral					
Critical care area		1.3(0.8-1.9)	0.43	1.2 (0.97-1.5)	0.53
Non critical care ward		1.00(0.75-1.2)		1.00 (0.92-1.1)	
outpatient		1.00(reference)		1.00(reference	

	Unadjusted analysis	***P* values**	**Adjusted analysis**	***P* value**
	Odds Ratio (CI)		Odds Ratio (CI)	
Age(years)				
18-65	1.00 (reference)		1.00 (reference)	
> 65	3.1(1.7-5.7)	<0.001	2.8(1.7-7.3)	<0.001
Sex				

Male	0.86(0.71-2.9)	0.55	0.81(0.9-1.7)	0.83	
Female	1.00(reference		1.00 (reference)		
eGFR (ml/min per 1.73)					
≥60	1.00(reference		1.00(reference		
30-59	5.3(2.4-14.3)	<0.001	5.1(2.7-13.8)	<0.001	
<30	12.9(3.8-18.3)		11.3(3.5-16.8)		
proteinuria (g/dl)					
< 3	1.00 (reference)		1.00 (reference)		
≥ 3	1.3(0.78-1.7)	0.42			
Needle gauge					
14	1.14(0.67-1.9)		1.1(0.82-2)		
16	1.2(0.6-1.6)	0.71	1.1(0.7-1.9)	0.84	
18	1.00(reference)		1.00 reference		
Hemoglobin (mg/dl)					
<13	1.00(reference)		1.00(reference)		
11<13	1.8(0.8-5.9)	<0.001	1.7(0.9-4.5)	<0.001	
9 -11	2.8(1.3-5.9)		2.4(1.4-4.7)		
Platelets					
>150.000	1.00 (reference)		1.00(reference)		
100.000-150.000	1.3(0.75-1.9)	0.46	1.4(0.87-2)	0.75	
AKI					
Yes	1.5(0.8-2.2)	0.42	1.3(0.8-4.1)		0.34
No	1.00 reference		1.00 reference		
Chronic Allograft Nephropathy					
yes	1.7 (0.6-2.2)	0.24	1.4(0..66-1.8)		0.35
No	1.00 reference		1.00 reference		
Pre-biopsy blood pressure (mmHg)					
< 140 mmHg	1.00(reference)		1.00 reference		
140-159 mmHg	2.1(0.8-5.3)	0.07	1.8(0.76-5.1)		0.17
≥ 160	3.5(0.8-4.15)		3.3(0.89-7.2)		