Needle Size and the Risk of Kidney Biopsy Bleeding Complications

To the Editor: The percutaneous renal biopsy is an essential tool in the diagnosis and evaluation of kidney disease. Most renal biopsies are performed under direct ultrasound guidance with automated biopsy needles, techniques that have substantially reduced the risks of the procedure.[1–3] However, the kidney biopsy still carries a considerable risk of bleeding complications. Although certain risk factors for bleeding, including hypertension, acute kidney injury, female sex, and older age, have been well documented,[4] the association between the biopsy needle size and the rate of bleeding complications is unclear. Major complications, including hemorrhage requiring transfusion, angiographic intervention, nephrectomy, or death, have been reported in only around 2%–8% of renal biopsies, whereas minor complications, such as hematoma, are seen in anywhere from 17% to 33%.[4,5] Hematoma formation found on renal ultrasound is a direct assessment of post-biopsy bleeding and may be a more sensitive measure of bleeding than overt anemia or hemodynamic instability. At our institution, post-biopsy ultrasounds are routinely obtained as standard of care after kidney biopsy. We therefore conducted a retrospective cohort study of patients who underwent kidney biopsy, using post-biopsy hematoma as the endpoint of interest when comparing 14G versus 16G needles.

The study was conducted at Brigham and Women's Hospital in Boston, MA, between August 2014 and January 2016. We captured all biopsies that were performed under the supervision of a single nephrology attending, allowing for minimal variation in how procedures in our cohort were supervised and performed. The biopsies captured comprise the large majority of the ultrasound-guided renal biopsies conducted during the period of the study.

During the period of the study, the standard of care switched from the use of 14G to 16G needles, based on anecdotal observations of excessive numbers of hematomas noted in the 14G group. Spring-loaded, automated needles were used for all biopsies. All biopsies were conducted by or under the supervision of the same nephrology attending, and all patients were monitored for at least 6 hours after biopsy. A renal pathologist confirmed the adequacy of the sample at the time of the biopsy. The presence of a hematoma was ascertained by immediate post-biopsy ultrasound. We used electronic health record databases to capture demographic and clinical data. The outcome of interest was the occurrence of a post-biopsy hematoma. The secondary outcome was the change in hemoglobin concentration before and 6 hours after biopsy.

We used a χ^2 or *t*-test to compare baseline characteristics between patients with 16G and 14G needles. We used multivariate logistic regression to test the association between the needle size and the occurrence of a post-biopsy hematoma adjusted for clinical and demographic characteristics. We selected covariates that were previously shown to be associated with an increased risk of bleeding after biopsy including age, sex, needle size, platelet count, systolic blood pressure, and estimated glomerular filtration rate. We additionally adjusted for fellow performance of biopsies and the number of passes. Finally, we adjusted for the presence of >40% fibrosis on the biopsy as this was associated with a risk of hematoma in the univariate analysis. We used R, version 3.2.2, for all statistical analyses and considered $P < 0.05$ to be statistically significant.

Our cohort consisted of 86 patients with a mean age of 56.5 ± 16.9 years. Baseline characteristics, stratified by needle size and by the occurrence of a hematoma, are shown in Table 1. A 14G biopsy needle was used in 44 (51%) of patients and a 16G biopsy needle was used in the remaining patients. There were a similar proportion of patients who had inpatient biopsies in the 14G group compared with the 16G group (34% vs. 43%, respectively, $P = 0.54$). More passes were performed to obtain adequate samples in the 14G group compared with the 16G group (2.7 vs. 2.2, respectively, $P = 0.003$). There was no effect of the number of passes on the risk of hematoma ($P = 0.49$).

Hematoma formation was more frequent among individuals who underwent kidney biopsy using 14G needles compared with 16G needles (41% vs. 17%, respectively, $P = 0.03$). There was no difference in the diagnostic yield of glomeruli between the 2 groups (43 ± 21.6 vs. 37 ± 12.3 glomeruli, respectively, $P = 0.13$). There were no patients in whom the tissue obtained was inadequate to make a diagnosis. In a logistic regression analysis, the use of a 14G needle was associated with a significantly higher risk of hematoma (odds ratio 5.72, 95% confidence interval 1.54–25.7, $P = 0.01$) after multivariable adjustment for

Table 1. Baseline characteristics of the participants—16-gauge versus 14-gauge biopsy needle size; with and without hematoma

	16-gauge	14-gauge	P-value	With hematoma	Without hematoma	P-value
Demographics						
Age, mean (SD)	59.7 ± 15.1	53.18 ± 18.2	0.07	53.0 ± 17.6	57.7 ± 16.7	0.26
Female, n (%)	19 (45.2%)	23 (52.3%)	0.7	12 (48.0%)	30 (49.2%)	1.0
Lab values						
INR, median IQR	1 (0.95, 1.05)	1 (0.99, 1.01)	0.15	1 (1, 1)	1 (0.95, 1.05)	0.26
PTT, s (SD)	30.81 ± 6.5	30.01 ± 5.3	0.54	30.13 ± 5.2	30.51 ± 6.2	0.77
Pre-Hb, g/dl (SD)	11.33 ± 2.1	11.27 ± 2.0	0.88	11.23 ± 1.8	11.32 ± 2.1	0.84
Platelets, K/µl (SD)	273 ± 133.7	239.32 ± 69.5	0.15	293.24 ± 133.8	240.41 ± 90.0	0.07
Creatinine, mg/dl (SD)	3.04 ± 7.5	2.13 ± 1.8	0.45	2.12 ± 1.3	2.76 ± 6.4	0.46
Proteinuria, mg albumin/g creatinine (SD)	2937.62 ± 5942.6	2453.54 ± 2958.4	0.67	3945.07 ± 8182.8	2279.08 ± 2651.2	0.68
eGFR, ml/min per 1.73 m^2 (SD)	44.30 ± 27.0	51.00 ± 37.6	0.34	43.2 ± 32.4	49.6 ± 33.2	0.42
eGFR < 30, n (%)	14 (31.8%)	14 (66.7%)	0.003	11 (44%)	17 (72.1%)	0.03
BMI (SD)	27.24 ± 4.7	26.98 ± 5.08	0.42	26.70 ± 5.6	27.27 ± 4.6	0.68
Biopsy characteristics						
Left side, n (%)	34 (80.9%)	31 (70.5%)	0.38	21 (84%)	44 (72%)	0.38
Passes, n (SD)	2.19 ± 0.59	2.66 ± 0.83	0.003	2.52 ± 0.77	2.39 ± 0.76	0.49
Systolic blood pressure, mm Hg (SD)	134.38 ± 16.7	130.95 ± 16.8	0.35	133.20 ± 18.9	132.39 ± 15.9	0.85
Diastolic blood pressure, mm Hg (SD)	73.31 ± 10.9	71.45 ± 13.5	0.48	74.76 ± 12.3	71.38 ± 12.2	0.25
Fellow, n (%)	18 (42.9%)	28 (63.6%)	0.09	15 (60%)	31 (50.8%)	0.59
Inpatient biopsy, n (%)	18 (42.9%)	15 (34.1%)	0.54	8 (32%)	25 (41.0%)	0.59
Post Hb, g/dl (SD)	10.89 ± 2.0	10.67 ± 1.9	0.60	10.44 ± 1.7	10.92 ± 2.0	0.27
Hb drop, g/dl (SD)	0.44 ± 0.7	0.59 ± 0.7	0.31	0.80 ± 0.68	0.40 ± 0.69	0.02
Hb drop > 1 g/dl (SD)	8 (19.0%)	10 (22.7%)	0.88	9 (36%)	9 (14.8%)	0.06
Hematoma, n (%)	7 (16.7%)	18 (40.9%)	0.03	N/A	N/A	N/A
Pathology						
Glomeruli, mean (SD)	37.43 ± 12.3	43.23 ± 21.6	0.13	40.80 ± 20.3	40.23 ± 16.9	0.90
Interstitial fibrosis, % (SD)	31.67 ± 21.0	28.75 ± 21.9	0.53	40 ± 22.5	26.1 ± 19.7	0.01
Interstitial fibrosis >40%, n (%)	13 (31.0%)	14 (31.8%)	0.9	14 (56%)	13 (21.3%)	0.004

BMI, body mass index; eGFR, estimated glomerular filtration rate; INR, international normalized ratio; IQR, interquartile range; PPT, partial thromboplastin time.

commonly reported factors associated with post-biopsy complications, including age, gender, needle size, whether a fellow performed the biopsy, the kidney that was biopsied, number of passes, systolic blood pressure, and eGFR (Table 2). Other factors that were significantly associated with hematoma in the multivariable model included the platelet count and the presence of significant (>40%) fibrosis on the renal biopsy. The post-biopsy fall in hemoglobin levels was 0.4 g/dl greater in patients who had a post-biopsy hematoma (P = 0.03). Two patients experienced a major complication: one requiring angiographic intervention and the other requiring a urinary stent, both in the 14G group. Among individuals who underwent outpatient biopsy, one patient in the 16G group was admitted for observation because of biopsy-related issues, compared with 6 patients admitted in the 14G group (P = 0.12).

The use of 14G needles was associated with a higher complication rate without providing any appreciable benefit for diagnostic yield. Although the presence of a hematoma is a minor complication, it is associated with an increased risk of major complications. One study has shown that the absence of a hematoma 1 hour after biopsy was strongly associated with an uncomplicated post-biopsy course, although the presence of a

hematoma at 1 hour after biopsy was not predictive of a complicated post-biopsy course (positive predictive value of 43% and negative predictive value of 95% for predicting clinical complications).[6] Another study found that the presence of a perirenal hematoma >2 cm immediately after biopsy was the strongest predictor of more severe anemia the morning after biopsy.[7] The occurrence of a hematoma can also lead to longer hospital stays and higher treatment costs. We have previously shown that in our institution, outpatient biopsies are associated with an 82% decrease in costs

Table 2. Predictors of hematoma after renal biopsy

	Univariate model			Multivariate model		
Predictor	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
14-gauge versus 16-gauge	3.46	1.30–10.0	0.02	5.72	1.54–25.7	0.01
Left versus right side	2.03	0.65–7.71	0.25	2.05	0.48–10.4	0.35
Number of passes	1.24	0.67–2.25	0.48	0.99	0.42–2.28	0.98
Platelets (per 100 K/µl)	1.60	1.02–2.68	0.054	1.91	1.06–3.87	0.05
Interstitial fibrosis >40% versus <40%	4.70	1.76–13.1	0.002	5.86	1.53–25.6	0.01
Age (per 10 yr)	0.85	0.65–1.12	0.25	0.83	0.55–1.22	0.35
Female versus male	0.95	0.37–2.43	0.9	0.58	0.17–1.87	0.37

Factors adjusted for in the multivariate model: age, gender, needle size, whether fellow performed the biopsy, kidney that was biopsied, number of passes, platelet count, systolic blood pressure, eGFR, interstitial fibrosis (>40% vs. <40%).
CI, confidence interval; eGFR, estimated glomerular filtration rate.

relative to inpatient biopsies.[8] Although not statistically significant, there was a reduction in the number of admissions for observation in our cohort using 16G needles that, based on our prior research, likely reduced overall costs associated with the procedure.

Whether or not larger needles are associated with a higher complication rate after kidney biopsy is controversial. Smaller studies have found no association between needle size and major complications.[5,8,9] This may be due in part to the low overall event rate of major complications in these studies. In contrast, a large meta-analysis of biopsies from 1980 to 2011 found that the use of 14G needles was associated with a higher rate of transfusion after biopsy compared with 16G and 18G needles.[4] However, another large study using data from a Norwegian kidney biopsy registry spanning a similar time frame found that there was no difference in major complication rates between 14G and 16G needles,[10] although the overall rate of complications in that study was remarkably low. In addition, there was a trend towards a higher rate of complications in individuals using 18G needles, suggesting that there may have been a selection bias where patients perceived to be at a higher risk of bleeding were more likely to have a biopsy with smaller needles. More recently, a study comparing 14G and 16G needles found that there was no difference in adequacy but that the rate of post-biopsy hematoma was significantly higher with larger needles (39% vs. 22%).[11] These findings were comparable to the results of this study.

The findings of this study are limited due to the small sample size and its retrospective nature, which could introduce potential bias. Our findings suggest that there is a need to carefully weigh the potential risks of using a larger biopsy needle against the desire for more diagnostic tissue.

In conclusion, 16G needles result in fewer post-biopsy hematomas and have equivalent diagnostic yield compared with 14G needles for kidney biopsy.

Salena Cui[1], Howard T. Heller[2], Sushrut S. Waikar[1] and Gearoid M. McMahon[1]

[1]Renal Division, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA; and [2]Department of Radiology, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA
Correspondence: Gearoid M. McMahon, Renal Division, Brigham and Women's Hospital, MRB-4, 75 Francis St., Boston, Massachusetts 02115, USA. E-mail: gmmcmahon@partners.org

DISCLOSURE

All the authors declared no competing interests.

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