ORIGINAL RESEARCH & CONTRIBUTIONS

Accuracy and Implications of Percutaneous Renal Biopsy in the Management of Renal Masses

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Abstract

Introduction: Percutaneous renal biopsy in patients with renal masses is increasing. We investigated the accuracy of percutaneous renal mass biopsy results in patients undergoing evaluation of solid renal masses.

Methods: A retrospective review was performed of patients in the Kaiser Permanente Southern California Region who underwent computed tomography or ultrasound-guided percutaneous renal biopsy of a solid renal mass between January 2005 and December 2009. Patients were stratified by size of mass ($\leq$ 4 cm vs > 4 cm). Initial biopsy results were correlated with final pathology specimens after extirpation.

Results: Medical records of 126 patients (129 renal units with 132 biopsies) were reviewed. Initial diagnostic biopsies revealed 87 (66%) malignant, 38 (29%) benign, and 7 (5%) nondiagnostic lesions. Sixty-three patients (50%) ultimately underwent extirpative surgery (23 partial and 40 radical nephrectomies). Of these patients, the diagnostic accuracy of the initial percutaneous renal mass biopsy was 76%, with an overall sensitivity and specificity of 75.4% and 100%, respectively. The biopsy concordance to final histologic tumor subtype was 93%. Larger tumor size (odds ratio [OR], 2.20; 95% confidence interval [CI], 0.55 to 8.88) and increasing number of biopsies (OR, 2.50; 95% CI, 0.59 to 10.69) were associated with increasing accuracy of a biopsy result to predict cancer; however, these associations were not statistically significant.

Conclusion: Percutaneous renal mass biopsy is diagnostically accurate and has good sensitivity, specificity, and concordance with final pathologic renal cell carcinoma subtype. This diagnostic modality can assist in management of select renal masses as treatment options are expanding.

Introduction

The rising incidence of asymptomatic renal masses is largely due to a recent increase in cross-sectional imaging for various abdominal symptomatology.[1] Furthermore, recent surgical series have reported that up to 20% of small renal masses (tumors less than 4 cm) are benign and only 20% to 25% have potentially aggressive features.[2-4] However, despite an earlier detection of renal masses, cancer-specific deaths caused by renal cell carcinoma (RCC) have not concordantly declined, suggesting that some patients may be overtreated from aggressive surgical management.[5] Select patients may benefit from nonextirpative surgery with treatment modalities such as active surveillance or thermal ablation. This is especially appealing for patients who are poor surgical candidates or in those patients with a high likelihood of having benign lesions.[6]

With expanded treatment options for renal masses, there is also a concomitant need for predictive information to help stratify patients into appropriate risk categories. Previously, renal mass sampling was limited to patients with clinical findings suggestive of renal abscess, lymphoma, or metastatic carcinoma to the kidney. Moreover, it was believed that renal biopsy for solid renal tumors produced high false-negative results and was associated with significant morbidity. However, contemporary studies have found improved accuracy of renal biopsy to predict the histologic subtype and final nuclear grade, with minimal associated complications.[7,8] Therefore, renal mass biopsy may help guide clinical decision making and the management of patients with renal masses. The objective of our study was to review our experience with renal mass biopsy to determine its accuracy in patients undergoing evaluation of solid renal masses.

Methods

After approval from the institutional review board, we performed a retrospective chart review in the Kaiser Permanente Southern California Region of patients who underwent either computed tomography or ultrasound-guided percutaneous core renal biopsy (needle gauge range = 14Fr to 21Fr) of a solid renal mass from January 2005 to December 2009. Using documented physician diagnostic and procedural codes, the electronic medical records were queried to determine patients who underwent percutaneous renal biopsy. Most patients who underwent percutaneous renal biopsy were excluded from the cohort because the reason for renal biopsy was medical renal disease rather than renal mass. Further exclusion criteria included age younger than age 18 years and a diagnosis of urothelial carcinoma.

All available clinicopathologic data were assessed for patient demographics, including age, sex, and race. Patients

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also were stratified by size of renal mass, comparing small renal masses (≤ 4 cm) with larger renal masses (> 4 cm). All treatment decisions, including whether to recommend a renal biopsy, were made as per clinical assessment of the attending physician.

Initial biopsy results were evaluated and correlated to postoperative pathology specimens when extirpative surgery was performed. Biopsies of renal masses were classified as nondiagnostic if there was inadequate tissue sample, nondiagnostic material was obtained, or no surrounding renal parenchyma was noted.

Descriptive statistics of patient demographics, renal mass size, and RCC subtype with concordance were evaluated. Sensitivity and specificity were calculated to examine the accuracy of using renal mass biopsy to detect cancer. Logistic regression was used to calculate the unadjusted and adjusted odds ratio (OR) and 95% confidence interval (CI) when evaluating each risk factor. All statistical analyses were performed with SAS 9.1 (SAS Institute, Cary, NC). Additionally, treatment outcomes were evaluated in patients who underwent biopsy and did not undergo extirpative surgery.

Results

A total of 3541 medical records of patients who underwent renal biopsy were reviewed, and 126 patients were identified in the cohort (129 renal units with 132 biopsies) who met the study criteria over a 5-year period. Patient characteristics are summarized in Table 1. The mean age was 65.3 years, and the mean tumor size was 5.5 cm. Initial diagnostic biopsies revealed 87 (66%) malignant, 38 (29%) benign, and 7 (5%) nondiagnostic lesions (Table 2). Of the 126 patients identified, 40 (32%) underwent radical nephrectomy, 23 (18%) had a partial nephrectomy, and 63 (50%) did not have extirpative surgery. Patients who did not have extirpative surgery tended to be older (mean age, 68.6 years vs 61.5 years).

The diagnostic accuracy of the initial percutaneous renal mass biopsy to differentiate between benign and malignant specimens was 76%. The overall sensitivity for renal mass biopsy to detect cancer on final pathology specimens after extirpative surgery was 75.4%, with 100% specificity. The positive predictive value for patients who underwent extirpative surgery was 100%, with an 11.7% negative predictive value. The sensitivity and specificity for renal mass biopsy to detect cancer on final pathology specimens after extirpative surgery for small renal masses was 66.7% and 100%, respectively, with positive and negative predictive values of 100% and 11.1%, respectively. The concordance with RCC histologic subtype was 100% for small renal masses and 88.2% for renal masses larger than 4 cm (Table 3). Larger tumor size (OR 2.20; 95% CI, 0.55 to 8.88) and increasing number of biopsies (OR 2.50; 95% CI, 0.59 to 10.69) were associated with increasing accuracy of a biopsy to predict cancer; however, these associations were not statistically significant.

The mean age of patients who did not undergo extirpative surgery was 68.6 years (standard deviation [SD] = 13.5 years) with a mean tumor size of 5.8 cm (SD = 4.3 cm). Overall, 43% of patients with small renal masses underwent surveillance in comparison to 32% of patients with renal masses larger than 4 cm. If the initial biopsy result identified RCC, 12% and 13% of patients underwent surveillance if they had small renal masses or renal masses larger than 4 cm, respectively. Conversely, if the initial renal mass biopsy result was benign, 72% of patients with small renal masses underwent surveillance, whereas 80% of patients with larger renal masses received surveillance.

Discussion

The management of solid renal masses, particularly small renal masses, has met with paradigm changes since the days of radical nephrectomy for all localized renal cancers. Recent American Urological Association Guidelines for Management of Clinical Stage 1 Renal Mass listed active surveillance as an option to discuss with the healthy patient, and a reasonable option for management in patients with decreased life expectancy or extensive comorbidities.[1] The resurgence in interest

Table 1. Patient demographics

Demographic	Total	Did not have extirpative surgery	Underwent surgery	Partial nephrectomy	Radical nephrectomy
Number (%)	126	63 (50%)	63 (50%)	23 (18%)	40 (32%)
Mean age, years (SD)[a]	65.3 (14.6)	68.6 (13.5)	61.5 (14.1)	60.9 (16.0)	61.8 (13.1)
Sex, %[b]					
Women	33.3	28.6	38.1	56.5	27.5
Men	66.7	71.4	61.9	43.5	72.5
Mean tumor size, cm (SD)[c]	5.5 (3.7)	5.8 (4.3)	5.5 (3.2)	4.0 (2.6)	6.4 (3.2)
Race/ethnicity, %[d]					
Asian	3.2	0.0	6.3	0.0	10.0
Black	3.2	3.2	3.2	8.7	0.0
Hispanic	16.7	14.3	19.0	13.0	22.5
White	76.2	82.5	69.8	73.9	67.5
Other	0.8	0.0	1.6	4.3	0.0

[a] p value = 0.0176
[b] p value = 0.0330
[c] p value = 0.0459
[d] p value = 0.0177; not all totals equate to 100% because of rounding to one decimal place.
SD = standard deviation.

for the use of renal mass biopsy in the management of solid renal tumors has been driven by an increased impetus to maximally preserve renal function and by the recognition that a large number of small renal masses are benign or follow an indolent course. Currently, biopsy is routinely performed in the diagnosis and treatment of various tumors such as prostate, breast, and skin cancers; however, the role of renal biopsy for the management of renal masses has historically been limited. Typically, renal biopsy has been performed to evaluate renal masses with suspicion of metastatic disease, renal abscess, or lymphoma. Renal biopsy has not routinely been performed in the evaluation of renal masses because of concerns of high false-negative rates or associated morbidity from the procedure.[9] Complications associated with percutaneous renal biopsy include hemorrhage, infection, pneumothorax, development of an arteriovenous fistula, and percutaneous tract tumor seeding.[10,11] In our cohort of patients, there were no complications noted immediately after the renal biopsy.

… the advantage of a renal biopsy will be to guide the clinician in treating or following a patient with active surveillance.

In our series, as in many recent series, renal mass biopsy was performed with core needle biopsy (14 to 21 gauge). We report an overall accuracy of 76% and a nondiagnostic biopsy rate of 5.3%. Other contemporary series have reported higher accuracy rates for renal mass biopsy—around 97%—with similar, low nondiagnostic biopsy rates between 2% and 8%.[7,8,12-14] Our initial renal mass biopsy results had high concordance rates with tumor histologic subtype after extirpation (100% for small renal masses and 88.2% for renal masses > 4 cm). Other studies also reported strong correlations between percutaneous renal biopsy and final pathology specimens, with renal mass biopsy correctly identifying the histologic subtype in up to 85% of cases.[13] Compared with other studies, our cohort did have a large number of false-negative results for biopsy of small renal masses. The negative predictive value of biopsy results of small renal masses in our series was 11.1%, compared with 60% in other series.[14] In the literature, most specimens recorded as false negative actually represent biopsy procedures that failed for a technical reason, for example, difficult visualization, blood contamination of the aspirate, or erroneous targeting. The problem appears to be more frequent in small tumors and should be considered by the clinician and made known to the patient at the time of recommendation of renal biopsy of a small renal mass.[15]

In our cohort of 126 patients, we also tracked those who underwent renal biopsy for a solid renal mass but did not undergo extirpative surgery (63/126 = 50%). As expected, these patients were older (68.6 vs 61.5 years, $p < 0.0176$), and most had a benign diagnosis in the biopsy result (81%). However, unexpectedly, the mean tumor size was slightly larger in patients who did not undergo surgery than in those who did (5.8 cm vs 5.5 cm, $p = 0.0459$). We theorize that the clinician used age and possible life expectancy, rather than tumor size, as the gauge for recommendation of surgical intervention in these cases. Ultimately, the advantage of a renal biopsy will be to guide the clinician in treating or following a patient with active surveillance.

We acknowledge several study limitations that affected the interpretation of our results. This is a retrospective analysis of a select patient population. With our strict inclusion criteria, our study encompassed a small series of patients. Consequently, some statistical analyses, especially those evaluating concordance, may be underpowered. Nonetheless, our results are encouraging, and these data shed further

Table 2. Biopsy results

Type of biopsy specimen	Number/total (%) of biopsy specimens by size of renal mass	
	Mass ≤ 4 cm	Mass > 4 cm
All renal	60/132 (45.5)	72/132 (54.5)
Nondiagnostic[a]	6/60 (10.0)	1/72 (1.4)
Benign	21/60 (35.0)	17/72 (23.6)
Malignant	33/60 (55.0)	54/72 (75.0)
Nondiagnostic[a]		
Mass excised with surgery	1/6 (16.7)	1/1 (100.0)
Cancer in nephrectomy specimen	1/1 (100)	1/1 (100)
Benign		
Mass excised with surgery	8/21 (38.1)	7/17 (41.2)
Cancer in nephrectomy specimen	7/8 (87.5)	6/7 (85.7)
Malignant		
Mass excised with surgery	16/33 (48.5)	30/54 (55.6)
Cancer in nephrectomy specimen	16/16 (100.0)	30/30 (100.0)
Concordance to RCC subtype	12/12 (100.0)	15/17 (88.2)

[a] Inadequate tissue sample, nondiagnostic material, or no surrounding renal parenchyma.
RCC = renal cell carcinoma.

Table 3. Descriptions of positive biopsy and extirpative pathology specimens

Description	Number/total (%) by size of renal mass	
	Mass ≤ 4 cm	Mass > 4 cm
Patients with available data for subtype designation in biopsy and nephrectomy	12/25 (48.0)	17/38 (44.7)
Concordance to subtype in nephrectomy specimens	12/12 (100.0)	15/17 (88.2)[a]
RCC subtype breakdown of concordance		
Clear cell	9/12 (75.0)	12/15 (80.0)
Cystic	0/12 (0)	1/15 (6.7)
Papillary	3/12 (25.0)	2/15 (13.3)

[a] Pathology changed from biopsy pathology of clear cell RCC to chromophobe and papillary RCC in the final nephrectomy pathology.
RCC = renal cell carcinoma.

light on the current utility of renal mass biopsy. A prospective randomized trial would be important to further assess the merits of percutaneous renal mass biopsy. In addition, future renal mass biopsies may be combined with molecular analysis to further improve diagnostic and prognostic accuracy in the management of patients with renal masses.

Conclusion

Overall, the improved accuracy and low morbidity of percutaneous renal mass biopsy may help guide clinical decision making in select patients with renal masses. Renal mass biopsy may be performed to better risk stratify patients to determine appropriate candidates for more aggressive surgical treatment vs active surveillance and ultimately to prevent an overtreatment of those patients with benign biopsy results. Patients with nondiagnostic or benign results of renal mass biopsy should be considered for close surveillance or repeated biopsy because malignancy may be missed. Additionally, accurate histologic subtyping of renal masses may allow for more directed therapies against specific renal tumors as our understanding of the RCC tumor biology continues to evolve. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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References

1. Guideline for management of the clinical stage 1 renal mass [monograph on the Internet]. Washington, DC: American Urological Association Education and Research; 2009 [cited 2013 Feb 15]. Available from: www.auanet.org/resources.cfm?ID=442.
2. Chow WH, Devesa SS, Warren JL, Fraumeni JF Jr. Rising incidence of renal cell cancer in the United States. JAMA 1999 May 5;281(17):1628-31. DOI: http://dx.doi.org/10.1001/jama.281.17.1628
3. Frank I, Blute ML, Cheville JC, Lohse CM, Weaver AL, Zincke H. Solid renal tumors: an analysis of pathological features related to tumor size. J Urol 2003 Dec;170(6 Pt 1):2217-20. DOI: http://dx.doi.org/10.1097/01.ju.0000095475.12515.5e
4. Russo P. Should elective partial nephrectomy be performed for renal cell carcinoma > 4 cm in size? Nat Clin Pract Urol 2008 Sep;5(9):482-3. DOI: http://dx.doi.org/10.1038/ncpuro1177
5. Thomas AA, Aron M, Hernandez AV, Lane BR, Gill IS. Laparoscopic partial nephrectomy in octogenarians. Urology 2009 Nov;74(5):1042-6. DOI: http://dx.doi.org/10.1016/j.urology.2009.04.099
6. Hollingsworth JM, Miller DC, Daignault S, Hollenbeck BK. Rising incidence of small renal masses: a need to reassess treatment effect. J Natl Cancer Inst 2006 Sep 20;98(18):1331-4. DOI: http://dx.doi.org/10.1093/jnci/djk115
7. Schmidbauer J, Remzi M, Memarsadeghi M, et al. Diagnostic accuracy of computed tomography-guided percutaneous biopsy of renal masses. Eur Urol 2008 May;53(5):1003-11. DOI: http://dx.doi.org/10.1016/j.eururo.2007.11.041
8. Wang R, Wolf JS Jr, Wood DP Jr, Higgins EJ, Jafez KS. Accuracy of percutaneous core biopsy in management of small renal masses. Urology 2009 Mar;73(3):586-91. DOI: http://dx.doi.org/10.1016/j.urology.2008.08.519
9. Thomas AA, Campbell SC. Small renal masses: toward more rational treatment. Cleve Clin J Med 2011 Aug;78(8):539-47. DOI: http://dx.doi.org/10.3949/ccjm.78a.10176
10. Lane BR, Samplaski MK, Herts BR, Zhou M, Novick AC, Campbell SC. Renal mass biopsy—a renaissance? J Urol 2008 Jan;179(1):20-7. DOI: http://dx.doi.org/10.1016/j.juro.2007.08.124
11. Volpe A, Kachura JR, Geddie WR, et al. Techniques, safety and accuracy of sampling of renal tumors by fine needle aspiration and core biopsy. J Urol 2007 Aug;178(2):379-86. DOI: http://dx.doi.org/10.1016/j.juro.2007.03.131
12. Yamaguchi Y, Simmons MN, Campbell SC. Small renal masses: risk prediction and contemporary management. Hematol Oncol Clin North Am 2011 Aug;25(4):717-36. DOI: http://dx.doi.org/10.1016/j.hoc.2011.04.007
13. Blumenfeld AJ, Guru K, Fuchs GJ, Kim HL. Percutaneous biopsy of renal cell carcinoma underestimates nuclear grade. Urology 2010 Sep;76(3):610-3. DOI: http://dx.doi.org/10.1016/j.urology.2009.09.095
14. Rybicki FJ, Shu KM, Cibas ES, Fielding JR, vanSonnenberg E, Silverman SG. Percutaneous biopsy of renal masses: sensitivity and negative predictive value stratified by clinical setting and size of masses. AJR Am J Roentgenol 2003 May;180(5):1281-7. DOI: http://dx.doi.org/10.1016/j.urolonc.2003.11.002
15. Shannon BA, Cohen RJ, de Bruto H, Davies RJ. The value of preoperative needle core biopsy for diagnosing benign lesions among small, incidentally detected renal masses. J Urol 2008 Oct;180(4):1257-61. DOI: http://dx.doi.org/10.1016/j.juro.2008.06.030

Conservative Services

Too much attention has been paid
to the excretory offices of the kidney
to the neglect of its conservative services.

— John Punnett Peters, MD, 1887-1955, American Medical Scientist