Percutaneous Biopsy of the Renal Mass: Fine Needle Aspiration or Core Biopsy?

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Running Title: Renal Mass Biopsy

Key words: Fine needle aspiration, core biopsy, renal tumors, cytology, renal cell carcinoma

Total number of text pages: 18; Tables: 5; Figures: 3

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This study is unfunded.

All authors have no financial disclosure.

This is the author's manuscript of the article published in final edited form as:

Yang, C. S., Choi, E., Idrees, M. T., Chen, S., & Wu, H. H. (2017). Percutaneous biopsy of the renal mass: FNA or core needle biopsy?. Cancer. https://doi.org/10.1002/cncy.21852

Precis: Both FNA and CB show excellent diagnostic accuracy when diagnosing renal neoplasia. There is a synergistic diagnostic advantage of combining FNA and CB techniques which significantly improved the diagnostic rate when compared with FNA alone (92% vs 72%, $p<0.05$) and was also better than CB alone (92% vs 87%).

Abstract

Background: In recent years, there have been increasing indications for percutaneous renal biopsy. Fine needle aspiration (FNA) with or without core biopsy (CB) has been used increasingly in the management of renal tumors at our institution.

Design: A computerized search of our laboratory records was conducted to retrieve FNA cases of renal masses as well as the correlating CB and/or nephrectomy specimens. The cases spanned a period of 10 years (2006-2015). The diagnoses were classified into five categories: malignant, suspicious for malignancy, neoplastic, atypical and negative/non-diagnostic. Based on the results of the nephrectomy specimens, the diagnostic rate, sensitivity and diagnostic accuracy were calculated among three groups: FNA only, CB only, and combined FNA and CB.

Results: A total of 247 cases of FNA with123 correlating CB and 101 followup nephrectomy specimens were identified. The diagnostic rate, sensitivity and diagnostic accuracy were 72%, 78%, and 96% for FNA; 87%, 92% and 94% for CB; and 92%, 92% and 94% for the combination group. Renal cell carcinoma (RCC) and its variants were the most common histologic diagnoses (112/174, 64%). Significant diagnostic discrepancy was noted in one case: a malignant melanoma that was misdiagnosed as RCC in both the preoperative FNA and in the CB.

Conclusion: Both FNA and CB demonstrate excellent diagnostic accuracy (96% and 94%). The combination of FNA and CB significantly improves the diagnostic rate when compared with either FNA alone (92% vs 72%, $p<0.05$) or with CB alone (92% vs 87%).

Introduction

The incidence of renal cell carcinoma (RCC) has increased during the past few decades largely due to the detection of small (<4 cm) renal masses (SRMs). The widespread use of advanced imaging techniques including ultrasonography (US), computed tomography (CT) and magnetic resonance imaging (MRI) for patients presenting with non-specific abdominal symptoms contributes to the rising incidence of SRMs. Surgical resection of these early-stage, potentially malignant renal tumors is also on the rise[1, 2]. However, a significant proportion of SRMs removed by nephrectomy are later proven to be either benign neoplasms or low-grade RCCs. These tumors usually have a relatively indolent biological and clinical behavior. Furthermore, early surgical intervention has not been shown to influence the mortality rate of kidney cancers[1, 3, 4]. Percutaneous renal biopsies before therapy can prevent overtreatment and unnecessary surgeries for patient with benign lesions. It can also provide useful information for patients with comorbidities who may not be good surgical candidates. These patients may benefit from alternative treatment options such as active surveillance and thermal ablative therapy. Additionally, due to the advent of targeted biologic therapies, it is clear that pre-treatment information regarding tumor pathology plays an important role in the management of patients with metastatic renal cell carcinoma[5-8]. In view of the abovementioned reasons, the spectrum of utility of percutaneous renal biopsy continues to expand in clinical practice, and it now plays an ever increasing role in clinical decision-making.

At our institution, fine needle aspiration (FNA) was the first diagnostic procedure performed for the majority of percutaneous renal biopsies. The cases were attended by a cytopathologist for rapid on-site evaluation. Concurrent core biopsies (CB) were also obtained

for some of the cases. If core biopsies were not obtained at the time of FNA biopsy, additional multiple FNA passes (2 to 4 passes) were collected for processing into cell blocks.

In this study, we retrospectively reviewed 247 renal FNA cases with and without concurrent CB. Based on the results of the follow-up renal resection specimens, the sensitivity, diagnostic rate and diagnostic accuracy were calculated and compared among three groups. These groups included FNA alone, CB alone, and combined FNA and CB.

Materials and Methods

This study was approved by the Institutional Review Board of Indiana University (IRB protocol # 1607749519). A computerized search of our laboratory information system was performed over a 10-year-period from January 2006 to December 2015 to retrieve all FNAs of the kidney. All of the renal aspirates were performed using 22-25 gauge needles under CT or ultrasound guidance. Concurrent or subsequent core biopsies were obtained using 18 gauge needles. Paired air-dried (Diff-Quik-Stained) and ethanol-fixed (Papanicolaou-stained) smears were prepared. Rapid on-site evaluation was routinely performed by either a cytopathologist and/or a cytotechnologist to evaluate the adequacy of the specimen. Typically, 2-5 FNA passes were performed initially. If the FNA sample was considered adequate, additional aspirates (2-4 passes) for cell block were also performed. If the specimens were still deemed inadequate after the on-site evaluation, the radiologist performing the procedure opted to obtain core biopsies in some cases. The decision to obtain core biopsies depended on many factors including the on-site evaluation results and the preference of radiologists, urologists or oncologists.

The FNA diagnoses were classified into 5 categories: malignant (M), suspicious for malignancy (SM), neoplastic (N), atypical (A) and negative/non-diagnostic (ND). Negative cases cannot simply be interpreted as "benign" because of the possibility of sampling errors. We therefore classified all the negative cases as non-diagnostic. This category included samples containing normal glomeruli, tubular epithelial cells, blood only, necrotic debris, etc. All correlating surgical pathology reports including CB and nephrectomy specimens were reviewed. For statistic calculation purpose, we grouped M, SM, N and A diagnoses as "positive." ND diagnoses were considered "negative." Based on the nephrectomy results, the sensitivity was calculated for the identification of both benign and malignant tumors. The diagnostic accuracy was determined by the rate of concordance between the diagnoses rendered for the biopsies compared with those for the nephrectomy specimens.

A Chi-square test using an online calculator was performed to compare diagnostic rate of FNA alone, core biopsy alone, and the combination group. The result was found to be significant at $p < 0.05$. (http://www.socscistatistics.com/tests/chisquare/Default.aspx).

Results

Renal FNA was performed for 247 patients including 131 males and 116 females. The patients' ages ranged from 3 to 96 with a mean of 63. There were only 2 pediatric cases (<1%). The first case was a 3-year-old female patient who was diagnosed with Wilms' tumor by both FNA and core biopsy. These results were later confirmed by nephrectomy. The second case was a 14-year-old male patient with high-grade B-cell lymphoma diagnosed by both FNA and core biopsy in conjunction with a flow cytometry study obtained during the FNA procedure. A follow-up nephrectomy was not performed for the second patient. Excluding these two patients, the age of

patients in our study ranged from 22 to 96 with a mean of 63.6. Correlating core biopsies were obtained for 123 patients and follow-up nephrectomy specimens were identified in 101 patients. Of the 124 cases that only had FNAs performed without a concurrent CB, 29 were consultation cases, 22 had no cell blocks and 73 had both direct smears and cell blocks prepared. Thirty-six (49%) of the 73 cases with cell blocks contained sufficient tissue within the cell block for further ancillary studies. Of these latter 36 cases, immunocytochemical stains were performed in 17 cases (47%).

Of the 247 FNA cases, a diagnosis of M was rendered in 132 cases (53%), SM in 9 cases (4%), N in 24 cases (10%), A in 12 cases (5%) and ND in 70 cases (28%). Of the 123 diagnoses rendered for the core biopsies, a diagnosis of M was noted in 83 cases (67%), SM in 1 case (1%), N in 23 cases (19%), and ND in16 cases (13%). None of the core biopsies were diagnosed as A. Of the 123 cases for which both FNA and CB were performed concurrently, the final diagnoses for the combined samples showed M in 84 cases (68%), SM in 2 cases (2%), N in 26 cases (21%), A in 1 case (1%) and ND in 10 cases (8%). (**Table 1**) The diagnostic rates for FNA, CB and the combination group were 72%, 87% and 92% respectively. The diagnostic rate of the combination group was significantly higher than that of FNA alone (92% versus 72%, $p<0.05$). Using the nephrectomy diagnosis as the gold standard, the sensitivity for diagnosing renal neoplasia by FNA, CB and both modalities combined was 78%, 92% and 92%, respectively. The diagnostic accuracy was 96%, 94% and 94%, respectively. (**Table 2**)

If the “atypical” category was excluded from positive cohort, the sensitivity of FNA became slightly lower (77%) while the sensitivity for CB and both modalities remained unchanged. However our “atypical” FNA diagnosis was highly associated with malignant tumors. Of the 11 atypical FNA cases with histology followup, 9 (82%) of them were malignant.

Follow-up nephrectomy specimens were identified in 101 cases of FNA (**Table 3**) and 51 of these included a concurrent CB. (**Table 4**) All but one of the malignant diagnoses rendered on FNA or core biopsy were concordant with those rendered on the nephrectomy specimen. There were four additional cases with a minor diagnostic discrepancy. One RCC-unclassified was diagnosed as oncocytic neoplasm by both FNA and core biopsy. One RCC-clear cell type was diagnosed as a renal epithelial neoplasm by core biopsy and non-diagnostic by FNA. One case of leiomyosarcoma was diagnosed as a spindle cell neoplasm by FNA but was correctly diagnosed by the core biopsy.

One case of papillary RCC was correctly diagnosed by FNA while the core biopsy was non-diagnostic. Eleven nephrectomy-confirmed RCCs were diagnosed by the cores whereas the corresponding FNAs were non-diagnostic.

RCC and its variants accounted for the most common histologic diagnoses (65%, 113/174) that were rendered by core biopsy and/or nephrectomy. The most common subtype of RCC was the clear cell type (71 cases) (Figure 2), followed by papillary (21 cases) (Figure 3), unclassified (13 cases), chromophobe (4 cases) (Figure 4), translocation (3 cases) and clear cell papillary (1 case).

FNA was able to accurately subclassify 65% (40/62) of the RCCs compared with CB, which was able to subclassify 83% (30/36) of the tumors. The tumor size was recorded in 170 renal masses, and ranged from 0.9 to 21 cm (mean 5.02 cm). 48.8% of the tumors were less than 4 cm in size. When the tumors were subcategorized into three size groups (<2 cm, 2-4 cm, and > 4 cm), the diagnostic rates of FNA increased proportionally to the tumor size and were found to be 42.9%, 69.1% and 80.2% for each group, respectively.

Case report for major tumor type discrepancy:

In the one discordant case, a significant discrepancy was noted in the tumor classification: a malignant melanoma was misdiagnosed as RCC in both the preoperative FNA and CB. In this case, the patient was a 62-year-old male with a six centimeter right renal mass. He had no history of a prior malignancy. The patient underwent a CT-guided FNA biopsy of the mass and a CB was also obtained concurrently. The direct smears prepared from the FNA showed numerous epithelioid tumor cells distributed singly and in loose clusters. The cells contained eccentrically-located, round nuclei with prominent nucleoli and a moderate to abundant amount of eosinophilic cytoplasm. (**Figure 1A, 1B**) The concurrent CB showed sheets of malignant cells with similar cytomorphologic features. Additionally, in the CB, frequent mitotic figures and tumor necrosis were also appreciated.

To further evaluate the malignant cells, immunocytochemical stains were performed on paraffin-embedded sections cut from the cell block prepared from the FNA sample. The tumor cells showed immunoreactivity for CD10. They were negative for Gata-3, CD117 (C-KIT), Cytokeratin 7, E-cadherin, and carbonic anhydrase IX. Additional immunohistochemical stains were performed on paraffin-embedded sections cut from the CB. The tumor cells showed immunoreactivity for cytokeratin AE1/AE3, vimentin, and Pax-8. They were negative for cytokeratin 20, p63, and CD45. The immunoprofile of the tumor cells was originally thought to be consistent with a renal cell carcinoma, unclassified. The patient subsequently underwent a right nephrectomy.

Histologic sections of the nephrectomy specimen again showed a poorly differentiated epithelioid neoplasm with morphologic features similar to those described previously. (**Figure**

1C) Similarly, immunohistochemical staining showed positivity for cytokeratin AE1/AE3 and Pax-8. However, additional staining for Melan A, S100, HMB-45, and tyrosinase was also positive. These findings were highly supportive of a melanocytic neoplasm. The tumor cells were not immunoreactive for p63, cytokeratin 7, cytokeratin 20, and cytokeratin 5/6. These findings excluded a diagnosis of urothelial carcinoma. The tumor cells were also negative for inhibin and synaptophysin, making a diagnosis of adrenal cortical carcinoma less likely. Because of the unusual morphologic appearance of the tumor and the conflicting immunohistochemical staining results, the case was sent out for consultation at an outside institution. There, the immunohistochemical stains for pancytokeratin and Pax-8 were repeated and were reported as negative. Repeat immunohistochemical stains for S100 and HMB-45 were confirmed to be positive. Therefore, the tumor was ultimately diagnosed as a metastatic melanoma. The diagnostic discrepancy in this case was attributed to the conflicting immunohistochemical results. The primary site of the patient's melanoma was never identified, possibly due to tumor regression.

Discussion

Percutaneous renal biopsy was not widely utilized in the past due to concerns about safety and accuracy. It was reserved for patients who had solid tumors with atypical imaging features, unresectable renal tumors, abscesses, hematologic malignancy, or to rule out primary or secondary tumors in patients with a known extrarenal malignancy. However, recent large series of renal needle biopsy studies showed few or no major complications. This was likely due to better techniques including the use of guiding cannules[6, 7]. The management of small renal

masses (<4 cm) has also shifted away from traditional radical nephrectomy in favor of nephron-sparing surgeries such as partial nephrectomy and thermal ablation (radiofrequency or cryoablation). Additionally, more conservative management such as active surveillance for patients with concurrent comorbidities has been adopted[8, 9]. For these reasons, urologists have relied on information obtained from percutaneous renal mass biopsies for treatment-related decisions.

FNA and CB are two techniques that have been applied to obtain diagnostic material during percutaneous renal biopsy. Each technique has its own advantages. FNA may offer more extensive sampling from different areas within a mass and the cytologist can provide rapid on-site evaluation of specimen adequacy during the procedure. Furthermore, it guides the performing clinician in determining the correct location of the needle site. This helps to increase the diagnostic yield of the subsequent CB, if needed. Cell blocks prepared from the FNA samples may provide only limited information regarding tumor architecture but can be useful for immunocytochemical studies. Optimal CB samples are comparable to nephrectomy specimens in regards to tumor architecture and histologic features. Additionally, in most laboratories, tissue from CB is required for the extraction of DNA or RNA. This material can then be used for genomic analysis which can in turn guide the selection of new molecular targeted therapies[9-11]. Alternatively, however, FNA smears have also been shown to provide adequate genetic material for molecular testing[12].

Compared to CB, the average sensitivity of FNA in diagnosing malignancy is lower (76% for FNA versus 97% for CB)[6]. Our study also shows that CB is more sensitive (92% versus 78%) than FNA. Generally, CB is more likely to provide a definitive diagnosis and is better for subclassifying RCC[5, 13, 14]. Our study showed fewer atypical and suspicious diagnoses rendered

by the CB (1%) compared with FNA (9%). CB also correctly subclassified a higher percentage of RCC (83%, 30/36) compared with FNA (65%, 40/62).

Notably, FNA was found to be a reliable method for diagnosing papillary RCC. The majority of papillary RCC cases (83%, 15/18) were accurately diagnosed by FNA in our series. FNA also correctly diagnosed 1 of 3 (33%) cases of chromophobe RCC, 20 of 35 (57%) cases of clear cell RCC, 0 of 2 cases of translocation associated RCC, and 3 of 4 (75%) unclassified RCC.

In our study, CB failed to provide correct subtyping in six cases due to limited diagnostic material. These included 2 cases of mucinous tubular and spindle cell carcinoma, 1 case of papillary RCC, 2 cases of clear cell RCC and 1 case of translocation-associated RCC.

The utilization of both FNA and CB has clearly been shown to demonstrate superior diagnostic capabilities as compared with FNA or CB alone[15-17]. Our data confirmed this and showed a significantly higher diagnostic rate for the combination group compared with FNA alone (92% versus 72%, $p<0.05$) and CB alone (87%). Of the 16 non-diagnostic CB cases in our study, FNA was able to provide a diagnosis in 6 of the cases including 2 RCCs, 2 oncocytic neoplasms, 1 angiomyolipoma and 1 suspicious for RCC. CB was able to provide a diagnosis in 27 out of 36 cases reported as nondiagnostic by FNA. These cases included 17 RCCs, 6 oncocytic renal neoplasms, 3 angiomyolipomas and 1 suspicious for RCC.

The combination group also showed a high sensitivity (92%) and diagnostic accuracy (94%) for renal neoplasms. In cases of complex cystic lesions, CB was likely to increase the diagnostic accuracy when combined with FNA as compared with FNA alone. Conversely, CB alone was often unable to obtain diagnostic material in large tumors with extensive tumor necrosis. FNA was able to accurately subtype two out of six cases that were unable to be classified by CB (1 papillary and 1 clear cell type RCC).

Full concordance of the Fuhrman grade between the CB and nephrectomy specimens was noted in 62% of the cases. When the tumors were classified into low-grade (Fuhrman I-II) and high-grade (Fuhrman III-IV) categories, concordance increased to 79%. Discordant grading results may be attributed to interobserver variability and/or tumor heterogeneity. Fuhrman grading was not performed for FNA specimens. Future studies for grading RCC by FNA are needed.

Tumor size may contribute to the success of the percutaneous biopsy. Lechevallior et al found that the biopsy failure rate is higher in tumors ≤ 3 cm compared with that of tumors > 3 cm (37% versus 3%)[17]. In this study, we subdivided our FNA cases based on three size groups: < 2 cm, 2-4 cm, and > 4 cm. We found that the diagnostic rate increased in proportion to the tumor sizes (42.9%, 69.1% and 80.2%). For very small renal tumors (≤ 2 cm), Li et al suggested that the combination of CB and FNA had higher diagnostic success rate because FNA is able to provide more extensive sampling from different areas of the tumor whereas the CB is more limited in regards to sampling[18].

Additionally, the decision to perform a nephrectomy relied heavily on imaging data. Only 31% and 25% of non-diagnostic cases on FNA and core biopsy had a followup nephrectomy. Small sized tumors were more likely to be monitored via active surveillance.

The diagnosis of renal oncocytic neoplasms is regarded as the most challenging of all the renal neoplasms. The differential diagnoses include renal oncocytoma, eosinophilic variant of chromophobe renal cell carcinoma, and unclassified low grade oncocytic RCC. Ancillary studies such as Hale's colloidal iron and cytokeratin 7 (CK 7) immunohistochemical staining performed on the CB or the cell block may be helpful in distinguishing between renal oncocytoma and eosinophilic variant of chromophobe RCC. Renal oncocytomas are usually negative or only

focally positive for Hale's colloidal iron in a luminal distribution. Additionally, oncocytomas are usually only focally positive for CK7. In contrast, eosinophilic variant of chromophobe renal cell carcinomas are positive for Hale's colloidal iron in a reticular pattern and are diffusely positive for CK7. Occasionally, ancillary studies cannot be performed due to limited diagnostic material. In these circumstances, the tumor is best classified as oncocytic neoplasm[15, 19]. In our series, there were 11 oncocytic neoplasms and 8 oncocytomas (Figure 5) diagnosed by either FNA or CB. Of these, 3 cases had a follow-up nephrectomy. One of these cases was an oncocytoma diagnosed by FNA that was later diagnosed as an unclassified low-grade oncocytic RCC on the nephrectomy specimen. The other two cases were diagnosed as oncocytic neoplasms by CB. The final nephrectomy diagnoses for these cases revealed one unclassified low-grade oncocytic RCC and one renal cell neoplasm of oncocytosis.

Tumors that fall into the category of oncocytoma/oncocytic neoplasm with absence of high-grade nuclear atypia are considered either benign or of low malignant potential. Regardless of the specific diagnosis, clinical management is similar and includes partial nephrectomy, active surveillance, and thermal ablative therapy. At our institution, the majority of patients with these tumors (82%) received active surveillance.

Both FNA and CB are highly specific and have a high positive predictive value in diagnosing renal tumors. In our study, there were no false positive diagnoses found in either the FNA or CB cases. However, a major diagnostic discrepancy in tumor classification was noted in one case: a malignant melanoma was misdiagnosed as RCC in both the preoperative FNA and CB. Retrospective review of the FNA smears demonstrated typical morphologic features of melanoma including a dyshesive cellular pattern, epithelioid cells with eccentrically located round nuclei, prominent nucleoli and occasional binucleation. Melanoma is a great mimicker and

should be in the differential diagnosis whenever a tumor with unusual morphologic features is encountered during the examination of renal biopsies.

In conclusion, both FNA and CB show excellent diagnostic accuracy when diagnosing malignancy. Our study demonstrated the synergistic diagnostic advantage of combining FNA and CB techniques. The combination of FNA and CB significantly improved the diagnostic rate when compared with FNA alone (92% vs 72%, $p<0.05$) and was also better than CB alone (92% vs 87%).

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Figure Legends

Figure 1. FNA cytology of metastatic melanoma to kidney (A, Papanicolaou-stained x400; B Diff-Quik-stained x400); corresponding nephrectomy histological section (C, H&E stained, x400)

Figure 2. FNA cytology of clear cell renal cell carcinoma. Tumor cells contain clear to finely vacuolated and granular cytoplasm and rounded nuclei with prominent nucleoli. (A, Papanicolaou-stained x400; B Diff-Quik-stained x400)

Figure 3. FNA cytology of papillary renal cell carcinoma. Tumor cells contain small, uniform oval nuclei with fine chromatin and occasional grooves (A, Papanicolaou-stained x400), and demonstrate papillary structures and fibrovascular cores (B Diff-Quik-stained x200)

Figure 4. FNA cytology of chromophobe renal cell carcinoma. The cells are round to oval with a well-defined, thickened cell membrane and contain variegated cytoplasm ranging from dense, granular, and vacuolated to fluffy or flocculent with occasional perinuclear clear zone. The nuclei are round to oval with irregular nuclear membrane and occasional binucleation. (A, Papanicolaou-stained x400; B Diff-Quik-stained x400)

Figure 5. FNA cytology of oncocytoma. The smears show dispersed, isolated tumor cells with abundant uniform granular cytoplasm and well demarcated cell borders. The nuclei are small and round with smooth contours and occasional binucleation. (A, Papanicolaou-stained x400; B Diff-Quik-stained x400)

Table 1 Subcategory of diagnoses of renal mass rendered by FNA alone, CB alone and combination of both FNA and CB.

Diagnosis	**FNA**	**CB**	**FNA + CB**
Malignant	132 (53%)	83 (67%)	84 (68%)
Suspicious for malignancy	9 (4%)	1 (1%)	2 (2%)
Neoplasm	24 (10%)	23 (19%)	26 (21%)
Atypical	12 (5%)	0	1 (1%)
Non-diagnostic	70 (28%)	16 (13%)	10 (8%)
Total	247	123	123

FNA, fine needle aspiration; CB, core biopsy

Table 2 Comparisons of diagnostic rate, sensitivity, specificity and diagnostic accuracy.

Procedure (total number)	**Number of followup nephrectomy (% of total procedure)**	**Diagnostic rate**	**Sensitivity**	**Diagnostic accuracy**
FNA alone (n=247)	101 (41%)	72%	78%	96%
CB alone (n=117)	51 (44%)	87%	92%	94%
FNA + CB (n=117)	51 (44%)	92%	92%	94%

FNA, fine needle aspiration; CB, core biopsy

Table 3 Histologic Correlation of Renal FNA Diagnoses with Nephrectomy specimens

FNA Diagnosis	**Number of followup nephrectomy (% of FNA cases)**	**Nephrectomy Diagnosis (No)**
Malignant N = 132	65 (49%)	RCC- Clear cell (31) RCC- Papillary (18) RCC- Chromophobe (3) RCC- Translocation (2) RCC- Unclassified (4) Wilms' tumor (1) Sarcoma (2) High grade urothelial carcinoma (3) Metastatic melanoma (1)
Suspicious for malignancy N = 9	5 (56%)	RCC- Clear cell (3) RCC- Papillary (1) RCC- Unclassified (1)
Neoplasm N = 24	2 (8%)	RCC- Unclassified (1) Sarcoma (1)
Atypical N = 12	7 (58%)	RCC- Clear cell (4) RCC- Papillary (1) RCC- Mucinous tubular and spindle cell (1) Benign cyst (1)
Non-diagnostic N = 70	22 (31%)	RCC-Clear cell (14) RCC- Papillary (1) RCC- Chromophobe (1) RCC- Translocation (1)

		High grade urothelial carcinoma (1) Metastatic endometrial carcinoma (1) Oncocytoma (1) Benign cyst (2)
Total N = 247	101 (41%)	

Table 4 Histologic Correlation of Renal Core Biopsy with Nephrectomy Specimens

Core Diagnosis	**Number of followup nephrectomy (% of FNA cases)**	**Nephrectomy Diagnosis (No)**
Malignant N = 83	44 (53%)	RCC- Clear cell (23) RCC- Papillary (8) RCC- Translocation (3) RCC- Unclassified (2) RCC- Mucinous tubular and spindle cell (1) Wilms' tumor (1) Sarcoma (3) High grade urothelial carcinoma (1) Metastatic melanoma (1) Metastatic endometrial carcinoma (1)
Suspicious for malignancy N = 1	0	
Neoplasm N = 23	3 (13%)	RCC- Clear cell (1) RCC- Unclassified (1) Oncocytoma (1)
Atypical N = 0	0	
Non-diagnostic N = 16	4 (25%)	RCC-Clear cell (3) RCC- Papillary (1)
Total N = 123	51 (41%)	