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Research Article

Single-Centre Retrospective Analysis of the Diagnostic Yield and Safety of Image-Guided Percutaneous Core-Needle Biopsy of Renal and Perirenal Masses

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ABSTRACT

Background. Image-guided percutaneous core-needle biopsy is increasingly used to characterise renal and perirenal masses before definitive management, but its performance in mixed paediatric-and-adult referral practice, particularly in resource-limited settings, is not well described.

Objective. To determine the diagnostic yield and safety of image-guided percutaneous core-needle biopsy of renal and perirenal masses in a single interventional radiology service.

Methods. We retrospectively reviewed 25 consecutive image-guided percutaneous core biopsies of renal and perirenal masses performed in one service, with histopathology reported at two reference laboratories, between December 2021 and September 2024. Procedural details, tissue adequacy, immunohistochemistry use, final histological diagnosis and complications were recorded. Diagnostic yield was defined a priori as a biopsy providing a specific histological diagnosis sufficient to direct management; a broader yield estimate additionally counted biopsies that confirmed a neoplasm without finalising the entity. Proportions are reported with 95% Wilson confidence intervals (CI).

Results. The cohort comprised 17 children and 8 adults (15 male, 10 female); median lesion size was 7.0 cm (range 3.3–14.4). All biopsies used an 18-gauge semi-automatic needle; 20 (80%) were ultrasound-guided and 5 (20%) CT-guided, with a median of 3 passes (range 2–6). Tissue was adequate in 20/25 (80%) and immunohistochemistry was required in 24/25 (96%). A specific histological diagnosis was achieved in 18/25 (72.0%; 95% CI 52.4–85.7%); when biopsies confirming a neoplasm without a final entity were included, the yield rose to 22/25 (88.0%; 95% CI 70.0–95.8%). Three biopsies (12.0%; 95% CI 4.2–30.0%) were non-diagnostic or preliminary. Wilms tumour (n=9) and neuroblastoma (n=4) predominated in children; clear cell renal cell carcinoma and other adult malignancies were seen in adults. Complications occurred in 8/25 (32.0%; 95% CI 17.2–51.6%) and were exclusively minor (SIR class A–B): self-limiting pain (n=4), focal haematoma (n=3) and a vasovagal episode (n=1); there were no major complications, transfusions, embolisations, tract seeding or procedure-related deaths.

Conclusions. In this single-centre series, image-guided percutaneous core biopsy of renal and perirenal masses achieved a diagnostic yield comparable to published adult experience and was safe, with only minor complications. Near-universal reliance on immunohistochemistry underscores that such a service requires ready access to a full ancillary pathology panel.

Keywords: Renal Mass, Percutaneous Biopsy, Core-Needle Biopsy, Diagnostic Yield, Interventional Radiology, Wilms Tumour, Renal Cell Carcinoma, Complications.

INTRODUCTION

The characterisation of renal and perirenal masses has shifted from a purely imaging-based, surgical paradigm towards one in which pre-treatment histology increasingly informs management. In adults, the wider use of active surveillance and ablation for small renal masses, and of systemic therapy tailored to tumour subtype in advanced disease, has renewed interest in percutaneous renal tumour biopsy as a means of establishing histology

before committing a patient to a specific pathway.[1,3]

The evidence base in adults now supports percutaneous core biopsy as an accurate and safe procedure when performed with modern coaxial technique, and contemporary systematic reviews report low non-diagnostic rates and a very small risk of significant bleeding or tract seeding.[1–3] In children, the role of biopsy is more contested: the Children's Oncology Group treats any biopsy as upstaging a Wilms tumour, whereas the International Society of Paediatric Oncology permits pre-chemotherapy biopsy without altering stage and reserves it for atypical presentations, older children, or when a non-Wilms diagnosis such as rhabdoid tumour would change management.[5,6]

Much of the published literature derives from high-volume specialist centres,[1,2] and reports that mix paediatric and adult renal-mass biopsies within a single interventional radiology service, particularly outside high-income settings, are scarce. We therefore audited the diagnostic yield and safety of image-guided percutaneous core-needle biopsy of renal and perirenal masses in our institution, across the full paediatric-to-adult age range, to describe real-world performance and to identify the operational requirements of such a service.

MATERIALS AND METHODS

Study Design and Population

This was a single-centre retrospective case series. We identified consecutive patients who underwent image-guided percutaneous core-needle biopsy of a renal or perirenal (including retroperitoneal, adrenal and directly related metastatic) mass between December 2021 and September 2024, referred through a single interventional radiology practice. Histopathological reporting was performed at two reference laboratories. Twenty-five biopsy episodes in 25 patients met the inclusion criteria and had a retrievable final histopathology report.

Biopsy technique

All procedures were performed percutaneously under real-time image guidance (ultrasound or computed tomography) using an 18-gauge semi-automatic core-biopsy needle. The choice of guidance modality, anaesthesia (local anaesthesia or sedation) and number of passes was at operator discretion according to lesion location, patient age and cooperation. The number and length of cores were recorded from the pathology gross description.

Outcome definitions

The primary outcome was diagnostic yield, defined a priori as a biopsy that provided a specific histological diagnosis sufficient to direct management. Biopsies that confirmed a neoplasm but did not finalise the tumour entity (for example, "malignant neoplasm, favour renal origin" or a descriptive round-blue-cell/spindle-cell diagnosis with an open differential) were classified separately as descriptive/deferred and were additionally combined with specific diagnoses to produce a broader, neoplasm-confirming yield estimate. Biopsies yielding no usable tumour diagnosis, requiring repeat sampling, showing only non-representative (for example, therapy-related) changes, or issued as preliminary pending further work-up were classified as non-diagnostic. Tissue adequacy and immunohistochemistry use were recorded from the report. Complications were graded using the Society of Interventional Radiology (SIR) adverse-event classification.[7]

Statistical analysis

Categorical variables are summarised as counts and percentages and continuous variables as median and range. Proportions for yield and complications are reported with 95% Wilson score confidence intervals, which are appropriate for small samples. Given the sample size, analyses are descriptive and no formal hypothesis testing or multivariable modelling was undertaken.

RESULTS

Cohort and Procedural Characteristics

The 25 patients comprised 17 children (aged approximately 2 months to 12 years) and 8 adults (22–72 years); 15 were male and 10 female. Lesions were predominantly renal, with a minority of perirenal, retroperitoneal, adrenal or metastatic sites biopsied within the same service. The median largest lesion dimension on imaging was 7.0 cm (range 3.3–14.4). Ultrasound guidance was used in 20 biopsies (80%) and CT in 5 (20%). All biopsies used an 18-gauge semi-automatic needle. Sedation and local anaesthesia were used in comparable proportions (13 and 12 respectively), and the median number of passes was 3 (range 2–6). Patient and procedural characteristics are summarised in Table 1.

Table 1. Patient, Lesion and Procedural Characteristics (N = 25).

Characteristic	Value
Age Group — Children / Adults	17 (68%) / 8 (32%)
Sex — Male / Female	15 (60%) / 10 (40%)
Median Lesion Size, Cm (Range)	7.0 (3.3–14.4)
Guidance — Ultrasound / CT	20 (80%) / 5 (20%)
Anaesthesia — Sedation / Local	13 (52%) / 12 (48%)
Needle	18-Gauge Semi-Automatic (100%)
Median Number Of Passes (Range)	3 (2–6)

Tissue Adequacy and Diagnostic Yield

Tissue was judged adequate in 20 of 25 biopsies (80%); the remaining five yielded suboptimal or non-representative material. Immunohistochemistry was used to reach or support the diagnosis in 24 of 25 cases (96%). A specific histological diagnosis was achieved in 18 of 25 biopsies, giving a primary diagnostic yield of 72.0% (95% CI 52.4–85.7%). A further four biopsies confirmed a neoplasm without finalising the entity; counting these, the broader neoplasm-confirming yield was 22 of 25 (88.0%; 95% CI 70.0–95.8%). Three biopsies (12.0%; 95% CI 4.2–30.0%) were non-diagnostic or preliminary: one inconclusive result requiring rebiopsy, one showing only therapy-related change in a clinically known Wilms tumour, and one preliminary report pending further work-up. Diagnostic outcomes are shown in Table 2.

Table 2. Diagnostic Outcome of Biopsy (N = 25).

Outcome Category	N (%)
Specific Histological Diagnosis	18 (72.0%)
Neoplasm Confirmed, Entity Deferred	4 (16.0%)
Non-Diagnostic / Preliminary	3 (12.0%)
Primary Diagnostic Yield (Specific)	18/25 = 72.0% (95% CI 52.4–85.7)
Broad Yield (Neoplasm Confirmed)	22/25 = 88.0% (95% CI 70.0–95.8)
Tissue Adequate	20/25 = 80.0%
Immunohistochemistry Used	24/25 = 96.0%

Histopathological Spectrum

The histological spectrum differed markedly by age. In children, Wilms tumour (nephroblastoma) was by far the commonest diagnosis (n = 9), followed by neuroblastoma (n = 4) and rhabdoid / INI-deficient tumour (n = 2); a fat-poor angiomyolipoma was diagnosed in one older child, and one biopsy in a clinically known Wilms tumour showed only therapy-related change. In adults, clear cell renal cell carcinoma (n = 2) and single cases of metastatic urothelial carcinoma, poorly differentiated carcinoma with squamous differentiation, dedifferentiated liposarcoma and an unclassified spindle-cell neoplasm were seen, together with two malignant neoplasms that remained unresolved on biopsy. The spectrum by age group is shown in Table 3.

Table 3. Final Biopsy Diagnosis by Age Group.

Diagnosis	Children	Adults	Total
Wilms Tumour / Nephroblastoma	9	0	9
Neuroblastoma	4	0	4
Rhabdoid / INI-Deficient Tumour	2	0	2
Clear Cell Renal Cell Carcinoma	0	2	2
Angiomyolipoma	1	0	1
Metastatic Urothelial Carcinoma	0	1	1
Poorly Diff. Carcinoma (Squamous)	0	1	1
Dedifferentiated Liposarcoma	0	1	1
Unclassified Spindle-Cell Neoplasm	0	1	1
Malignant Neoplasm, Entity Pending	0	2	2
Non-Representative (Therapy Change)	1	0	1
Total	17	8	25

Biopsy–Resection Concordance

A surgical reference standard was available in two children who proceeded to nephrectomy. In both, the resection confirmed Wilms tumour. Notably, one of these biopsies had been inconclusive (a spindle-to-round-cell neoplasm with a differential that included Wilms tumour with rhabdomyoblastic differentiation versus embryonal rhabdomyosarcoma) and the other descriptive (a round-blue-cell neoplasm), yet both proved to be Wilms tumour on resection, with a shift in the dominant histological component after preoperative chemotherapy. This mirrors the recognised observation that blastema-rich pre-treatment biopsies frequently show predominantly epithelial or stromal, or necrotic, components at nephrectomy.[4]

Safety

Complications occurred after 8 of 25 biopsies (32.0%; 95% CI 17.2–51.6%) and were exclusively minor, corresponding to SIR class A–B.[7] These were self-limiting procedural pain (n = 4), focal haematoma requiring no intervention (n = 3) and a single vasovagal episode. No major complication occurred: there were no episodes requiring transfusion or embolisation, no clinically evident tract seeding, and no procedure-related death. Complications are summarised in Table 4.

Table 4. Complications (N = 25).

Complication	N (%)	SIR Class
None	17 (68.0%)	—
Self-Limiting Pain	4 (16.0%)	A–B
Focal Haematoma (No Intervention)	3 (12.0%)	A–B
Vasovagal Episode	1 (4.0%)	A–B
Any Complication	8 (32.0%)	All Minor
Major Complication	0 (0%)	—

DISCUSSION

In this single-centre series spanning the full paediatric-to-adult age range, image-guided percutaneous core-needle biopsy of renal and perirenal masses provided a specific histological diagnosis in 72% of cases and confirmed a neoplasm in 88%, while remaining non-diagnostic in only 12%. All complications were minor. These findings are consistent with the contemporary adult literature, in which systematic reviews report good diagnostic accuracy for malignancy and subtype and low non-diagnostic rates when modern coaxial 18-gauge technique is used, and in which significant bleeding and tract seeding are rare.[1–3]

Our uniform use of an 18-gauge semi-automatic needle aligns with the technique favoured in that literature,[1,3] and because needle calibre was constant it could not confound yield in this cohort. The predominance of ultrasound guidance reflects the large proportion of children and of bulky masses, in which real-time ultrasound is convenient and avoids ionising radiation; CT was reserved mainly for deeper retroperitoneal or adult lesions.

The paediatric composition of the cohort deserves emphasis. Wilms tumour and neuroblastoma dominated, and the biopsies that were most clinically valuable were arguably those that identified, or raised, a non-Wilms diagnosis — including two INI-deficient/rhabdoid tumours — since these are precisely the situations in which international paediatric guidelines regard biopsy as justified.[5,6] Our two biopsy–resection pairs reproduce the classic finding of the UK Children's Cancer Study Group Wilms tumour study, in which a substantial minority of clinically typical Wilms tumours yield a different or non-diagnostic biopsy result and in which the blastemal component prominent at biopsy is frequently altered after chemotherapy.[4] This reinforces that a descriptive or blastema-predominant paediatric biopsy should be interpreted together with imaging and clinical context rather than in isolation.

The single most consistent operational finding was that immunohistochemistry was required in 96% of cases to reach or support the diagnosis. For a renal-mass biopsy service this is a concrete resource implication: core biopsy is only as useful as the ancillary pathology behind it, and a unit offering these procedures must guarantee access to a broad immunohistochemical panel and to expert paediatric and uropathology reporting. The two biopsies that remained "malignant neoplasm, entity pending" illustrate the corollary — that limited core material can confirm malignancy yet leave subtyping to a subsequent excision.

The overall complication rate of 32% may appear high, but this reflects the capture of minor, self-limiting events such as transient pain and small haematomas; no patient sustained a major complication, required transfusion or embolisation, or showed tract seeding. This safety profile is in keeping with, and if anything slightly more benign than, historical paediatric series in which a fall in haemoglobin and local pain were common but serious events rare.[4] The absence of observed tract seeding is reassuring but must be read against the small sample and limited follow-up rather than taken as evidence of its impossibility.

Limitations

This study has important limitations. It is retrospective and small (n = 25), drawn from a single interventional radiology practice and reported through two laboratories, which limits precision — reflected in wide confidence intervals — and generalisability, and introduces selection bias in which lesions were referred for biopsy. A surgical reference standard was available in only two patients, so true diagnostic accuracy (sensitivity, specificity and biopsy–resection concordance) could not be formally established and yield here denotes the ability to render a diagnosis rather than its correctness. Procedural and complication data were assembled retrospectively and subtle or delayed events, including tract seeding, may be under-captured. Finally, systematic radiological–pathological correlation and clinical outcomes were beyond the scope of this dataset. Larger, prospective, multi-operator studies with routine surgical correlation are needed to confirm these findings.

CONCLUSION

In a single-centre, mixed paediatric-and-adult population, image-guided percutaneous core-needle biopsy of renal and perirenal masses achieved a diagnostic yield comparable to published adult experience and was safe, producing only minor, self-limiting complications. The near-universal need for immunohistochemistry indicates that the value of the procedure is inseparable from access to a full ancillary pathology service. These results support the continued, judicious use of percutaneous core biopsy to characterise renal and perirenal masses across the age range, while highlighting the need for larger prospective series with surgical correlation.

Declarations

Funding: None declared.

Conflicts of Interest: None declared.

Data Availability: The de-identified dataset is available from the corresponding author on reasonable request.

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