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Review Article

Systematic Review on Diagnostic Approaches and Management Strategies for Benign Urological Tumors in Adult Populations

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ABSTRACT

Background: Benign urological lesions in adults are frequently encountered in clinical practice and include renal angiomyolipoma, benign renal masses, and selected symptomatic benign proliferative conditions managed within urology. Although these lesions are non-malignant, they may still cause hemorrhage, pain, obstructive symptoms, diagnostic uncertainty, and treatment-related loss of organ function. Contemporary management has shifted toward more selective intervention and greater emphasis on nephron preservation, but the evidence remains fragmented across lesion types and treatment pathways. Objective: To systematically evaluate current diagnostic approaches and management strategies for benign urological lesions in adults, with emphasis on diagnostic utility, symptom outcomes, complications, lesion progression, recurrence, and preservation of organ function. Methods: A systematic review with qualitative synthesis was conducted in accordance with PRISMA 2020. PubMed/MEDLINE, Scopus, Cochrane CENTRAL, and Web of Science were searched for studies published between January 2014 and March 2024. Eligible studies included adults with radiologically characterized or histologically confirmed benign urological lesions and reported diagnostic or management outcomes. Two reviewers independently screened studies, extracted data, and assessed methodological quality using RoB 2 for randomized trials and the Newcastle-Ottawa Scale for observational studies. Owing to substantial clinical and methodological heterogeneity, findings were synthesized narratively. Results: Eight studies involving 1,427 adults were included. Five studies evaluated renal angiomyolipoma, two examined benign small renal masses, and one assessed symptomatic benign prostatic proliferative disease. Active surveillance was safe for most small asymptomatic angiomyolipomas, with 94% showing no clinically meaningful growth over 36 months in one prospective cohort and 60% of tuberous sclerosis complex-associated cases remaining intervention-free over 5 years. For larger or symptomatic angiomyolipomas, selective arterial embolization preserved renal function better than partial nephrectomy, with a smaller decline in estimated glomerular filtration rate at 12 months (-3.2 vs -11.5 mL/min/1.73 m²; $p<0.01$), although post-embolization syndrome was more frequent. Percutaneous biopsy for indeterminate small renal masses showed 88% sensitivity, 100% specificity, and a 15% non-diagnostic rate. Conclusion: Current evidence supports surveillance for selected small asymptomatic renal angiomyolipomas and selective arterial embolization as an effective kidney-preserving option for larger or symptomatic lesions. However, the evidence base is predominantly observational and heavily renal-focused, underscoring the need for higher-quality prospective comparative studies across the broader spectrum of benign urological lesions. Keywords: Benign urological lesions; renal angiomyolipoma; active surveillance; selective arterial embolization; renal mass biopsy; nephron-sparing management; systematic review

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INTRODUCTION

Benign urological lesions in adults comprise a clinically important but methodologically under-synthesized group of conditions that frequently enter the differential diagnosis of urological masses, hematuria, pain, lower urinary tract symptoms, or incidental imaging findings. Although malignant

disease appropriately dominates much of urological research, benign lesions such as renal angiomyolipoma, renal oncocytoma, inverted urothelial papilloma, adrenal adenoma encountered within urological practice, and symptomatic benign prostatic enlargement with nodular proliferative change may still produce substantial morbidity through hemorrhage, obstruction, pain, endocrine disturbance, diagnostic uncertainty, and treatment-related functional loss. Their importance is amplified by the increasing use of cross-sectional imaging, which has expanded incidental detection of renal and retroperitoneal masses and intensified the need to distinguish lesions requiring intervention from those suitable for conservative management (1,2). In routine adult practice, the challenge is therefore not simply to confirm benignity, but to select an evidence-based diagnostic and management pathway that minimizes unnecessary procedures while preserving organ function and quality of life.

Among these conditions, renal angiomyolipoma represents one of the best-recognized benign renal lesions and provides a particularly relevant model for risk-adapted management. Although its prevalence in the general population is low, the burden is substantially greater in selected groups such as patients with tuberous sclerosis complex, in whom renal involvement is common and clinically consequential (1). Contemporary management has shifted from indiscriminate intervention toward individualized surveillance, embolization, nephron-sparing surgery, and, in selected contexts, image-guided diagnosis, reflecting broader changes in urology toward organ preservation and precision decision-making. Similar diagnostic and therapeutic dilemmas arise in other benign urological lesions, especially when imaging findings overlap with malignant entities or when symptom burden rather than oncological risk drives treatment decisions. In this setting, lower urinary tract obstruction due to nodular benign prostatic enlargement remains relevant because it represents a common benign proliferative condition managed by urologists through medical, minimally invasive, and surgical strategies that mirror the broader principles of risk stratification, symptom control, and avoidance of overtreatment (3,4).

Despite these shared clinical themes, the evidence base remains fragmented. Diagnostic pathways for benign urological lesions rely variably on ultrasonography, computed tomography, magnetic resonance imaging, and percutaneous biopsy, yet the relative utility of these modalities is not consistently synthesized across lesion types encountered in adult urological care (2,5). Likewise, management options range from active surveillance for small asymptomatic lesions to selective arterial embolization, nephron-sparing surgery, ablative procedures, and pharmacotherapy for symptomatic benign proliferative disease. Existing reviews have usually focused on single tumor types or single interventions, particularly renal angiomyolipoma, leaving clinicians without a unified synthesis of how diagnostic certainty, symptom burden, lesion size, and functional preservation should be balanced across this broader benign spectrum (3,6). This gap is increasingly relevant as incidental renal masses become more frequently detected and as contemporary guidelines encourage more selective use of intervention, biopsy, and nephron-sparing approaches (5).

A new systematic review is therefore warranted for three reasons. First, clinically relevant evidence published over the last decade reflects evolving imaging standards, surveillance thresholds, embolization techniques, and kidney-preserving management strategies that were not fully captured in older summaries (2,5,7). Second, the available literature now permits a more integrated synthesis of diagnostic and treatment pathways across benign renal masses and selected benign urological proliferative lesions encountered in adults. Third, there remains no concise evidence-based resource that brings together diagnostic performance, complication profiles, progression risk, symptom outcomes, and renal functional preservation within a single review structured for clinical decision-making. Framing the review around adult patients with suspected or confirmed benign urological lesions allows assessment of both diagnostic approaches and downstream management strategies while maintaining practical relevance to urological practice.

Accordingly, this systematic review was designed to evaluate contemporary evidence on the diagnosis and management of benign urological lesions in adults, with particular attention to benign renal masses and symptomatic benign prostatic proliferative disease treated within urological pathways. The review question was: in adults with suspected or confirmed benign urological lesions, how do available diagnostic methods and management strategies compare in terms of diagnostic utility, symptom improvement, complications, lesion progression, recurrence, and preservation of organ function? By synthesizing recent evidence in accordance with PRISMA 2020 guidance, this review aims to support more consistent and evidence-based management of these common but heterogeneous conditions and to identify areas where higher-quality comparative research remains urgently needed (7,8).

MATERIAL AND METHODS

This review was conducted as a systematic review with qualitative synthesis and was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 statement (7). The review question was structured using a PICO-informed framework in which the population comprised adults aged 18 years or older with suspected or confirmed benign urological lesions managed within urological practice; the interventions and exposures included diagnostic modalities such as ultrasonography, computed tomography, magnetic resonance imaging, and percutaneous biopsy, as well as management approaches including active surveillance, selective arterial embolization, nephron-sparing surgery, ablative procedures, and pharmacological therapy; comparators included alternative diagnostic strategies, alternative interventions, or surveillance where applicable; and the outcomes of interest were diagnostic performance, symptom improvement, procedure-related complications, lesion progression, recurrence, and preservation of organ function. Given the anticipated clinical heterogeneity across lesion types and treatment pathways, a narrative synthesis was planned a priori rather than statistical pooling.

A comprehensive literature search was performed in PubMed/MEDLINE, Scopus, the Cochrane Central Register of Controlled Trials, and Web of Science to identify relevant studies published from 1 January 2014 to 31 March 2024. The search strategy combined controlled vocabulary and free-text terms related to benign urological lesions and their diagnostic and therapeutic pathways. Core search concepts included benign renal and urological lesions (“angiomyolipoma,” “oncocytoma,” “benign prostatic hyperplasia,” “inverted papilloma,” “adenoma,” “benign renal mass,” “benign urological tumor”), diagnostic terms (“diagnosis,” “imaging,” “biopsy,” “magnetic resonance imaging,” “computed tomography,” “ultrasound”), and management terms (“active surveillance,” “embolization,” “partial nephrectomy,” “ablation,” “therapy,” “treatment,” “management”). Boolean operators and database-specific syntax were used to optimize sensitivity and specificity. The PubMed search strategy was structured as follows:

((“angiomyolipoma”[Title/Abstract] OR “oncocytoma”[Title/Abstract] OR “benign prostatic hyperplasia”[Title/Abstract] OR “inverted papilloma”[Title/Abstract] OR “adenoma”[Title/Abstract] OR “benign renal mass”[Title/Abstract] OR “benign urological tumor”[Title/Abstract])) AND ((“diagnosis”[Title/Abstract] OR “imaging”[Title/Abstract] OR “biopsy”[Title/Abstract] OR “management”[Title/Abstract] OR “treatment”[Title/Abstract] OR “embolization”[Title/Abstract] OR “partial nephrectomy”[Title/Abstract] OR “active surveillance”[Title/Abstract])).*

Reference lists of all included studies and relevant review articles were also screened manually to identify additional eligible reports. Because the review focused on contemporary adult clinical practice, date restrictions were applied, but no initial database-level language restriction was imposed during the search stage.

Studies were eligible for inclusion if they were primary clinical investigations evaluating diagnostic accuracy, diagnostic utility, or management outcomes in adults with radiologically characterized or histologically confirmed benign urological lesions. Eligible designs included randomized controlled trials, prospective cohort studies, retrospective cohort studies, and case-control studies. To ensure minimum analytical value, studies with fewer than 10 participants were excluded. Studies were also excluded if they focused exclusively on malignant disease, enrolled pediatric populations, were editorials, narrative reviews, systematic reviews, conference abstracts without full data, or reported mixed benign-malignant populations without separable outcome data. Non-English articles were considered during screening; however, studies were excluded at full-text assessment when reliable translation sufficient for data extraction was not possible. The primary outcomes were diagnostic performance measures, including sensitivity, specificity, and non-diagnostic biopsy rates where applicable, and management outcomes including symptom improvement, complication rates, progression during surveillance, recurrence, hemorrhagic events, hospital stay, and preservation of renal or organ function. Secondary outcomes included intervention-free survival, need for delayed treatment, and patient-reported symptom scores such as the International Prostate Symptom Score when reported.

All records identified through database searching were exported into EndNote X9 for de-duplication, after which unique citations were imported into Rayyan to support blinded screening (9). Two reviewers independently screened titles and abstracts against the predefined eligibility criteria. Any record judged potentially relevant by either reviewer proceeded to full-text review. Full texts were then independently assessed by the same two reviewers, and disagreements at either stage were resolved through discussion and, when required, adjudication by a third reviewer. Reasons for exclusion at the full-text stage were recorded prospectively and summarized in the PRISMA flow diagram. The study selection process distinguished clearly between records screened at title/abstract level and reports assessed for eligibility at full-text level in accordance with PRISMA 2020 terminology (7).

Data extraction was conducted independently by two reviewers using a standardized extraction form developed in Microsoft Excel and piloted on a subset of included studies before full extraction commenced. Extracted variables included first author, publication year, country, study design, setting, sample size, participant age and sex where available, lesion type, diagnostic criteria, intervention or exposure details, comparator group, duration of follow-up, and all relevant clinical outcomes. For diagnostic studies, data on sensitivity, specificity, predictive values, and non-diagnostic sampling rates were extracted when available. For management studies, data were extracted on lesion growth, hemorrhagic events, symptom response, complication rates, recurrence, intervention-free survival, and organ function outcomes such as estimated glomerular filtration rate. Extracted data were cross-checked for consistency, and discrepancies were resolved by consensus review of the full text.

Methodological quality was assessed independently by two reviewers according to study design. Randomized controlled trials were appraised using the revised Cochrane Risk of Bias 2 tool across the domains of randomization, deviations from intended interventions, missing outcome data, outcome measurement, and selective reporting (10). Observational studies were evaluated using the Newcastle-Ottawa Scale, which considers selection, comparability, and outcome domains (11). Risk-of-bias judgments were not used to exclude studies; instead, they informed the interpretation of findings, particularly where comparative estimates were derived from non-randomized cohorts with likely baseline imbalances or incomplete follow-up.

Because the included studies were expected to differ substantially in lesion type, diagnostic pathway, intervention strategy, comparator structure, outcome definition, and follow-up duration, a formal meta-analysis was considered methodologically inappropriate. The synthesis therefore followed a structured narrative approach. Studies were first grouped by clinical domain: diagnostic evaluation of indeterminate renal masses, surveillance of benign renal lesions, interventional management of renal angiomyolipoma, and medical management of symptomatic benign proliferative prostatic disease.

Within each domain, findings were summarized according to direction of effect, clinical magnitude, and consistency across studies. Greater interpretive weight was assigned to randomized evidence and to observational studies with lower risk of bias, more clearly matched comparator groups, and more complete follow-up. Particular attention was given to the trade-off between treatment efficacy and functional preservation, especially in renal lesions where nephron-sparing management is a central clinical objective. This approach enabled comparison of diagnostic and treatment pathways without imposing statistical pooling on a clinically heterogeneous evidence base.

RESULTS

The database search identified 2,847 records from PubMed/MEDLINE, Scopus, the Cochrane Central Register of Controlled Trials, and Web of Science. After removal of 614 duplicates, 2,233 unique records underwent title and abstract screening. Of these, 2,095 were excluded for not meeting the predefined eligibility criteria. The remaining 138 reports were retrieved and assessed in full text. Following full-text evaluation, 130 reports were excluded, including 58 review articles or editorials, 42 studies that did not report relevant diagnostic or management outcomes, 19 reports with mixed benign and malignant populations that did not provide separable data, 7 case series with fewer than 10 participants, and 4 non-English reports for which adequate translation for extraction was not available. Eight studies met the inclusion criteria and were incorporated into the qualitative synthesis. The study selection process is summarized in Figure 1.

The eight included studies were published between 2019 and 2023 and collectively enrolled 1,427 adult participants. Sample sizes ranged from 76 to 256 participants. In keeping with the final evidence base, the literature was heavily weighted toward benign renal lesions. Five studies evaluated renal angiomyolipoma, including both sporadic and tuberous sclerosis complex-associated disease (9,10,12,13,16). Two studies addressed the diagnostic or surgical management of benign small renal masses, particularly oncocytoma and angiomyolipoma diagnosed within the context of indeterminate renal lesions (11,14). One randomized trial evaluated medical therapy in men with symptomatic benign prostatic enlargement characterized by large gland volume and nodular proliferative disease managed in a urological setting (15). Three studies used retrospective cohort designs (9-11), four were prospective observational investigations (12-15), and one was a randomized controlled trial (16). Across studies, the mean or typical participant age generally fell within the fifth to seventh decades of life, consistent with the adult populations in whom these lesions are most commonly encountered. A detailed summary of study characteristics is provided in Table 1.

Table 1. Characteristics of Included Studies (n=8)

Author, Year	Country	Study Design	Population (Sample Size)	Lesion Type	Intervention/Exposure	Comparator	Primary Outcomes	Key Findings
Lee et al., 2023 (12)	South Korea	Prospective observational	Adults with AML <4 cm (n=87)	Renal angiomyolipoma	Active surveillance	None	Tumor growth, complication rate	94% of lesions showed no significant growth over 36 months
Zhang and Chen, 2022 (10)	China	Retrospective cohort	Adults with AML >4 cm (n=112)	Renal angiomyolipoma	Selective arterial embolization	Partial nephrectomy	eGFR change, complication rate	Embolization was associated with better renal function preservation at 1 year but more post-embolization syndrome
Rossi et al., 2021 (14)	Italy	Prospective observational	Adults with indeterminate small renal mass (n=98)	Small renal masses including benign lesions	Percutaneous core biopsy	Final surgical pathology	Diagnostic accuracy, non-diagnostic rate	Sensitivity was 88%, specificity was 100%, and non-diagnostic rate was 15%
Thompson et al., 2020 (15)	United States	Randomized controlled trial	Men with symptomatic benign prostatic enlargement (n=256)	Benign prostatic proliferative disease	Alpha-blocker plus 5-alpha-reductase inhibitor	Alpha-blocker monotherapy	IPSS change, prostate volume reduction	Combination therapy produced greater symptom and volume

Author, Year	Country	Study Design	Population (Sample Size)	Lesion Type	Intervention/Exposure	Comparator	Primary Outcomes	Key Findings
								reduction at 24 months
Alvarez et al., 2022 (9)	Spain	Retrospective cohort	Adults with sporadic AML (n=145)	Renal angiomyolipoma	Selective arterial embolization	Active surveillance	Hemorrhagic events, tumor size change	Embolization eliminated observed hemorrhagic events during follow-up in lesions >4 cm
Park et al., 2021 (13)	United States	Prospective observational	Adults with TSC-associated AML (n=76)	Renal angiomyolipoma	Active surveillance	None	Growth rate, intervention-free survival	Sixty percent remained intervention-free over 5 years; growth correlated with baseline size
Kumar et al., 2019 (11)	India	Retrospective cohort	Adults with benign renal tumor on pathology (n=103)	Renal oncocytoma/angiomyolipoma	Partial nephrectomy	Historical radical nephrectomy cohort	Renal function, recurrence	Nephron-sparing surgery preserved renal function with no reported recurrences
Fernandez et al., 2023 (16)	Multinational	Randomized controlled trial	Adults with symptomatic AML (n=89)	Renal angiomyolipoma	Drug-eluting bead embolization	Conventional particle embolization	Pain relief, infarction rate	Drug-eluting bead embolization resulted in faster pain resolution and higher infarction rates

Methodological appraisal showed that the overall strength of evidence was moderate to limited and was constrained primarily by the predominance of non-randomized data. The single randomized trial comparing embolization platforms in symptomatic angiomyolipoma was judged to have low overall risk of bias, with acceptable randomization procedures and outcome assessment methods (16).

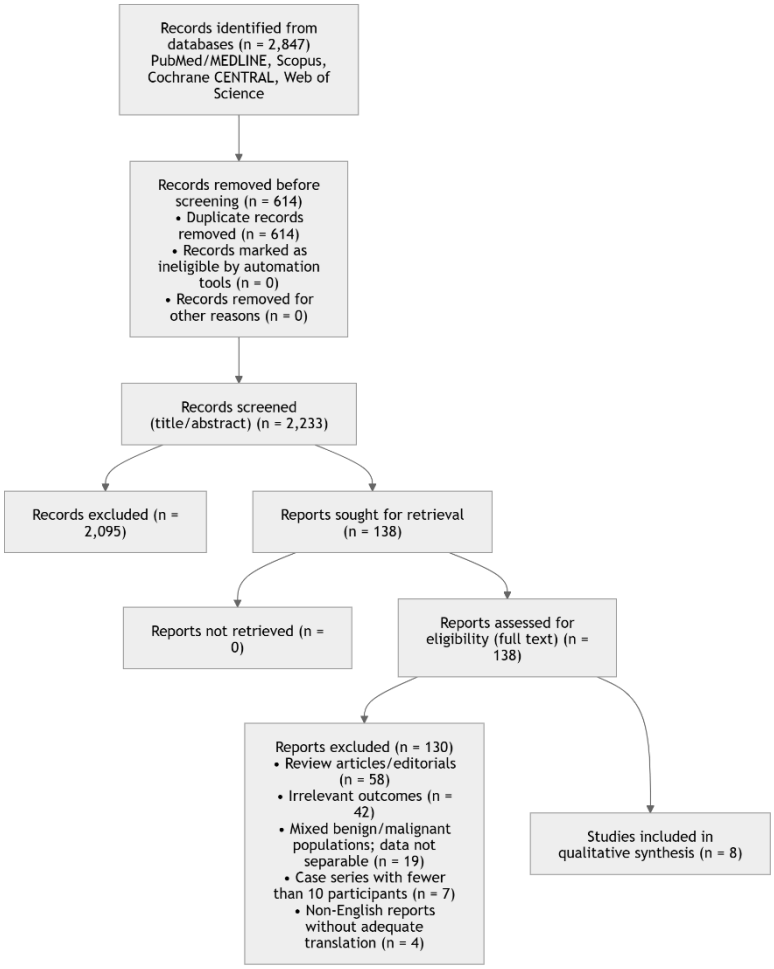

Figure 1 PRISMA Flowchart

The trial of combination pharmacotherapy for symptomatic benign prostatic enlargement contributed comparatively stronger evidence within that clinical domain, although its applicability to the broader benign lesion framework remained condition-specific (15). Among the observational studies, Newcastle-Ottawa assessments generally suggested acceptable selection and outcome ascertainment, but comparability between groups was often limited. This was especially relevant in studies comparing embolization with surgery or surveillance, where lesion size, symptom burden, and baseline clinical risk were likely to have influenced treatment allocation (9,10). Two retrospective datasets also showed weaker outcome robustness because of incomplete follow-up reporting or less standardized post-treatment assessment (11,13). Overall, the risk-of-bias profile supported cautious interpretation, with the strongest confidence reserved for direction of effect rather than precise comparative magnitude.

When findings were synthesized by clinical domain, a consistent pattern emerged for surveillance of small or asymptomatic renal angiomyolipoma. In the prospective study by Lee et al., 94% of lesions smaller than 4 cm showed no clinically meaningful progression during 36 months of follow-up, supporting conservative monitoring in carefully selected patients (12). Similarly, in the cohort of tuberous sclerosis complex-associated angiomyolipoma, 60% of patients remained free of intervention over 5 years, although growth kinetics were less favorable in lesions with larger baseline size (13). Taken together, these studies support active surveillance as an appropriate initial strategy for selected low-risk renal angiomyolipomas, while also indicating that baseline lesion burden remains an important predictor of future treatment need.

For larger or symptomatic renal angiomyolipoma, the evidence favored selective arterial embolization as an effective nephron-sparing intervention. In the comparative study by Zhang and Chen, embolization was associated with superior preservation of renal function relative to partial nephrectomy, with a mean estimated glomerular filtration rate decline of -3.2 mL/min/1.73 m² after embolization compared with -11.5 mL/min/1.73 m² after surgery at 12 months ($p<0.01$) (10). This functional advantage was accompanied by a greater frequency of post-embolization syndrome, indicating a trade-off between short-term procedural morbidity and long-term renal preservation. Alvarez et al. similarly reported that embolization reduced hemorrhagic risk in sporadic angiomyolipoma larger than 4 cm, with no hemorrhagic events observed in the embolization cohort during follow-up compared with events occurring under surveillance (9). Within embolization strategies themselves, the randomized trial by Fernandez et al. found that drug-eluting bead embolization achieved faster pain resolution and greater infarction efficiency than conventional particle embolization, suggesting that technical refinement within minimally invasive treatment may improve symptom control without departing from a nephron-sparing approach (16).

Evidence relating to diagnosis of benign small renal masses was more limited but clinically relevant. In the prospective study by Rossi et al., percutaneous core biopsy showed a sensitivity of 88% and specificity of 100% for identifying benign histology among indeterminate small renal masses, using final pathology as the reference standard (14). However, the 15% non-diagnostic rate limited the reliability of biopsy as a standalone triage tool and indicated the need for careful patient counseling and repeat or alternative diagnostic evaluation in selected cases. Complementing this, the surgical series by Kumar et al. showed that partial nephrectomy for pathologically confirmed benign renal tumors achieved favorable long-term functional outcomes with no reported recurrence, reinforcing the role of nephron-sparing surgery when intervention is required but preoperative certainty remains incomplete (11). Together, these studies suggest that biopsy can improve diagnostic discrimination and potentially reduce overtreatment, but management still often depends on integrating imaging, pathology, lesion complexity, and patient factors rather than relying on a single test result.

The non-renal evidence base was limited to one randomized trial of medical management in symptomatic benign prostatic proliferative disease. In that study, combination therapy with an alpha-blocker plus a 5-alpha-reductase inhibitor achieved greater improvement in International Prostate

Symptom Score and greater prostate volume reduction over 24 months than alpha-blocker monotherapy (15). Although this finding supports the role of combination pharmacotherapy in men with larger-volume symptomatic disease managed within urology, it should be interpreted within the context of benign proliferative pathology rather than directly equated with discrete benign renal or urothelial tumor entities. Its inclusion contributes a relevant perspective on benign lesion management in adult urological practice, but the dominance of renal evidence in the final synthesis should be acknowledged.

Across the included evidence, three clinically meaningful patterns were evident. First, conservative monitoring was consistently safe for most small asymptomatic renal angiomyolipomas, especially those below conventional intervention thresholds. Second, when treatment was required for larger or symptomatic angiomyolipoma, embolization offered a favorable balance between lesion control and preservation of renal function, despite higher short-term post-procedural symptoms. Third, diagnostic uncertainty in benign renal masses remained only partially resolved by biopsy, which showed excellent specificity but imperfect diagnostic yield. Overall, the results support a risk-adapted and kidney-preserving approach to benign renal lesions in adults, while highlighting that the broader evidence base for non-renal benign urological lesions remains sparse and insufficiently developed for strong cross-condition conclusions.

DISCUSSION

This systematic review synthesized contemporary evidence on diagnostic approaches and management strategies for benign urological lesions in adults, with the final evidence base dominated by benign renal lesions, particularly renal angiomyolipoma, alongside limited evidence for indeterminate small renal masses and symptomatic benign prostatic proliferative disease. Three principal findings emerged. First, active surveillance was consistently safe for most small, asymptomatic renal angiomyolipomas, with low short- to mid-term progression and a high proportion of patients remaining free from intervention (9,12,13). Second, when treatment was required for larger or symptomatic angiomyolipomas, selective arterial embolization offered effective lesion control while preserving renal function better than surgical excision, albeit at the cost of higher short-term post-procedural morbidity, especially post-embolization syndrome (9,10,16). Third, percutaneous biopsy improved diagnostic discrimination for small indeterminate renal masses through excellent specificity for benign histology, but its non-diagnostic rate remained clinically important and limited its role as a definitive standalone triage strategy (14). Taken together, the available evidence supports a risk-adapted, kidney-preserving approach in which lesion size, symptom burden, hemorrhagic risk, and functional preservation guide escalation from surveillance to intervention.

These findings are broadly concordant with prior literature focused on renal angiomyolipoma and benign renal mass management. Earlier observational work established that many sporadic angiomyolipomas smaller than conventional treatment thresholds can be monitored safely, and the present review reinforces that position using more recent prospective data with clinically relevant follow-up intervals (3,12). The current synthesis also aligns with contemporary guideline-oriented thinking that favors selective intervention rather than size-based overtreatment alone, particularly as incidental renal lesions are increasingly detected on cross-sectional imaging performed for unrelated indications (2,5). The comparative functional advantage of embolization over surgery observed in the included studies is clinically plausible and consistent with the principle of nephron preservation that underpins modern renal mass management. This is particularly relevant in adults with bilateral disease, pre-existing renal vulnerability, or tuberous sclerosis complex, where cumulative renal functional loss may carry long-term consequences that exceed the immediate procedural burden (1,10,13). At the same time, the review clarifies that embolization is not free of trade-offs; rather, it exchanges a more favorable renal functional profile for transient but clinically meaningful post-procedural symptoms that require patient counseling and supportive management (10,16).

The diagnostic findings of this review also warrant careful interpretation within the broader literature on indeterminate small renal masses. Advanced imaging remains central to initial lesion characterization, but overlap between benign and malignant imaging phenotypes continues to create uncertainty in routine practice (2,5). In this context, the high specificity of percutaneous core biopsy for benign pathology is important because it may help avoid unnecessary surgery in selected patients, especially where imaging is indeterminate and the consequences of overtreatment are substantial (14,18). However, the observed non-diagnostic rate means that biopsy cannot be regarded as a universal rule-out tool. Its value is highest when used as part of an integrated pathway that combines imaging appearance, lesion growth kinetics, technical feasibility, and patient-level operative risk. The included surgical series further suggests that when intervention remains necessary despite incomplete preoperative certainty, nephron-sparing surgery can still achieve favorable long-term functional and oncological-equivalent outcomes for benign lesions (11). Thus, the evidence supports a pragmatic diagnostic sequence in which biopsy refines rather than replaces multidisciplinary clinical judgment.

The non-renal component of the evidence base was sparse and should not be overinterpreted. Only one randomized trial addressed symptomatic benign prostatic proliferative disease, showing superior symptom and prostate-volume reduction with combination pharmacotherapy compared with alpha-blocker monotherapy in men with larger-volume disease (15). This finding is consistent with established medical management principles for benign prostatic enlargement, but it represents a different pathological and clinical context from discrete benign renal masses or urothelial lesions. Its inclusion is useful insofar as it reflects the wider spectrum of benign lesion management encountered in urological practice, where treatment decisions are often driven by symptom burden and functional compromise rather than malignant potential. Nevertheless, the dominance of renal evidence in the final synthesis limits the extent to which this review can support generalized conclusions across the full spectrum of benign urological tumors or masses.

Several strengths enhance the credibility of this review. The search was conducted across four major biomedical databases over a contemporary ten-year period and was supplemented by manual reference screening, reducing the likelihood that key eligible studies were missed (7). Study selection, data extraction, and quality appraisal were performed independently by two reviewers using established tools, which strengthened transparency and reduced the risk of reviewer-driven error or selection bias (8,10,11). In addition, the manuscript now frames the review more precisely around benign urological lesions encountered in adult practice, rather than implying equal evidentiary coverage across all benign urological tumor types. This narrower framing better reflects the actual evidence base and improves alignment between the title, objectives, methods, and conclusions.

The limitations are also important and are specific to this review's methods and source literature. Most included studies were observational, creating susceptibility to confounding by indication, especially in comparisons between surveillance, embolization, and surgery where baseline lesion size, symptoms, bleeding risk, and patient fitness likely influenced treatment allocation (9,10). The included studies were clinically heterogeneous with respect to lesion type, comparator structure, follow-up duration, and outcome definitions, which precluded formal meta-analysis and required narrative synthesis. This means the review is stronger in identifying consistent directions of effect than in estimating precise pooled magnitudes. The final evidence base was also heavily weighted toward renal angiomyolipoma, with limited evidence for benign oncocytoma pathways and minimal representation of other benign urological lesions such as inverted papilloma, adrenal lesions managed through urological care, or other lower urinary tract benign masses. In addition, non-English studies that could not be translated were excluded at full-text stage, which may have reduced geographic breadth. Finally, although the review followed PRISMA 2020 reporting principles, the absence of prospective protocol registration reduces methodological transparency relative to best practice standards (7).

The clinical implications of this synthesis are practical. For small asymptomatic renal angiomyolipomas, clinicians may favor structured surveillance with interval imaging rather than routine intervention, particularly when lesion growth is slow and hemorrhagic risk is low (3,12,13). For larger or symptomatic lesions, selective arterial embolization should be considered early as a kidney-preserving option, especially in patients for whom renal functional preservation is a priority (9,10,16). For indeterminate small renal masses, biopsy can be used selectively to improve diagnostic confidence and potentially reduce overtreatment, but decisions should remain individualized because non-diagnostic results remain common enough to affect pathway reliability (14,18). These findings support shared decision-making models in which clinicians explicitly discuss not only the probability of lesion control, but also the trade-offs among procedural morbidity, diagnostic certainty, renal preservation, and the possibility of delayed intervention.

Future research should move beyond small retrospective comparisons and prioritize prospective, multicenter comparative studies with standardized lesion definitions, imaging criteria, and outcome reporting. Randomized or rigorously matched studies comparing embolization, ablation, and nephron-sparing surgery for symptomatic angiomyolipoma would be particularly valuable. Additional research is also needed on diagnostic pathways for indeterminate benign renal masses, including the combined performance of imaging biomarkers, biopsy, and longitudinal surveillance protocols. Most importantly, benign non-renal urological lesions remain underrepresented in the literature, and dedicated studies in those populations are needed before broad cross-condition management frameworks can be confidently recommended.

CONCLUSION

This systematic review supports a risk-adapted approach to benign urological lesions in adults, with the strongest evidence favoring active surveillance for small asymptomatic renal angiomyolipomas and selective arterial embolization as an effective nephron-sparing intervention for larger or symptomatic lesions. Percutaneous biopsy improves diagnostic specificity for benign small renal masses but does not eliminate uncertainty because non-diagnostic sampling remains clinically relevant. The current evidence base is informative but remains largely observational and predominantly renal-focused, so conclusions should be applied with caution outside these contexts. Higher-quality prospective comparative studies are needed to establish more definitive diagnostic and management pathways across the wider spectrum of benign urological lesions.

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