



Kidney-Sparing Surgery in High-Risk Upper Tract Urothelial Carcinoma: A Systematic Review of Patient Selection and Long-Term Outcomes

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Revised: 23 July 2026 Accepted: 24 September 2026 Published: 29 September 2026 How to cite : Friskiandi, F., & Soerohardjo, I. (2026). Kidney-Sparing Surgery in High-Risk Upper Tract Urothelial Carcinoma: A Systematic Review of Patient Selection and Long-Term Outcomes. <i>Contagion: Scientific Periodical Journal of Public Health and Coastal Health</i>, 8(3), 560–575.	<i>High-risk upper tract urothelial carcinoma (UTUC) is an aggressive disease for which radical nephroureterectomy (RNU) remains the standard treatment but is associated with significant postoperative renal function decline. Kidney-sparing surgery (KSS) has emerged as a potential alternative in carefully selected patients to preserve renal function while maintaining oncological control. However, evidence regarding long-term oncological and functional outcomes of KSS in high-risk UTUC remains limited and heterogeneous, and optimal patient selection criteria are not well defined. Therefore, this systematic review aims to evaluate the available evidence to clarify the role of KSS in this clinical setting. We conducted a PRISMA 2020-compliant systematic review of observational studies comparing KSS (segmental ureterectomy or endoscopic/percutaneous management) with RNU in adults with high-risk UTUC, defined by $\geq pT2$ stage, high-grade histology, tumor size ≥ 2 cm, multifocality, hydronephrosis, or variant histology. PubMed, Scopus, and Embase were searched. Survival outcomes, recurrence patterns, renal function, and complications were extracted. Due to study heterogeneity, results were synthesized narratively. Four retrospective comparative studies, including approximately 700 patients, were identified. Five-year cancer-specific and overall survival were comparable between KSS and RNU, ranging from approximately 70% to 86%. Ipsilateral upper-tract recurrence was higher following KSS, particularly after endoscopic management, while rates of distant metastasis and bladder recurrence were similar. Distal ureterectomy achieved oncologic outcomes comparable to RNU for distal ureter tumors, whereas renal pelvis or proximal ureter tumors had higher recurrence. KSS consistently preserved renal function better. Overall, KSS appears safe and effective for carefully selected patients with small, unifocal distal ureter tumors or imperative indications for nephron preservation. Caution is warranted for large, multifocal, or renal pelvic/proximal ureter tumors. Prospective studies and biomarker-based risk stratification are needed to refine patient selection.</i> Keywords: <i>Upper Tract Urothelial Carcinoma, Kidney-Sparing Surgery, Radical Nephroureterectomy, Survival, Renal Function.</i>

INTRODUCTION

Upper tract urothelial carcinoma (UTUC) accounts for approximately 5–10% of urothelial tumors and often presents with high-grade or invasive disease (Escobar et al., 2025). Radical nephroureterectomy (RNU) with bladder cuff excision remains the standard treatment for localized high-risk UTUC because of its reliable oncological control (Büttner et al., 2025; Rouprêt et al., 2021). However, removal of the entire kidney and ureter may substantially impair renal function, particularly in elderly patients and those with pre-existing chronic kidney

disease (CKD), potentially limiting eligibility for subsequent systemic therapy (Li et al., 2024; Raman & Shore, 2020).

Kidney-sparing surgery (KSS), including segmental or distal ureterectomy and endoscopic tumor ablation, aims to preserve renal function while maintaining oncological control. Current guidelines recommend KSS primarily for low-risk UTUC and selected patients with imperative indications, such as a solitary kidney, bilateral disease, or severe CKD. In contrast, RNU remains the standard treatment for most high-risk tumors characterized by high-grade histology, invasive features, multifocality, hydronephrosis, or other adverse characteristics (Masson-Lecomte et al., 2024). Nevertheless, selected distal ureteral tumors may also be considered for kidney-sparing approaches.

Recent evidence has challenged the assumption that all high-risk UTUC requires radical surgery. Retrospective comparative studies and meta-analyses suggest that carefully selected patients undergoing KSS may achieve cancer-specific and overall survival comparable to those treated with RNU, while experiencing better preservation of renal function (Büttner et al., 2025; Moore et al., 2025; Ślusarczyk et al., 2024). However, KSS is associated with a higher risk of ipsilateral recurrence and requires intensive surveillance. Moreover, available evidence remains heterogeneous, with variation in patient selection, definitions of high-risk disease, surgical techniques, and follow-up duration.

Therefore, this systematic review compares the long-term oncological and renal functional outcomes of KSS and RNU in patients with high-risk UTUC and identifies clinicopathological characteristics that may guide patient selection. By focusing specifically on high-risk disease and integrating survival, recurrence, and renal function outcomes, this review seeks to clarify the circumstances in which nephron-preserving treatment may be considered without compromising oncological control.

METHOD

This systematic review was conducted in accordance with the PRISMA 2020 guidelines. Eligibility criteria were defined a priori using the Population, Intervention, Comparator, Outcomes (PICO) framework. We included adult patients (≥ 18 years) with non-metastatic high-risk upper tract urothelial carcinoma (UTUC). High-risk disease was defined according to established guideline criteria and included one or more of the following: high-grade histology, tumor stage $\geq pT2$, tumor size ≥ 2 cm, multifocal tumors, hydronephrosis, or variant histology. Patients with normal contralateral kidneys as well as those with imperative indications for nephron preservation, such as a solitary kidney, bilateral UTUC, or baseline

chronic kidney disease, were eligible. Studies limited exclusively to low-risk UTUC were excluded.

The intervention of interest was kidney-sparing surgery (KSS), including segmental ureterectomy and endoscopic management (ureteroscopic or percutaneous tumor ablation), regardless of whether performed electively or for imperative indications. The comparator was radical nephroureterectomy (RNU) with bladder cuff excision. Both comparative studies and single-arm KSS series reporting oncological outcomes were included, with an emphasis placed on comparative evidence when available.

The primary outcomes were oncological outcomes, including cancer-specific survival, overall survival, recurrence-free survival, and metastasis-free survival. Recurrence patterns, including intravesical and ipsilateral upper tract recurrence, were also assessed. Secondary outcomes included renal functional preservation, rates of salvage RNU following initial KSS, perioperative outcomes, and major complications.

A systematic literature search was performed in PubMed (MEDLINE), Scopus, and Embase using predefined search terms related to UTUC, kidney-sparing surgery, and high-risk disease. For PubMed, the search strategy included ("Upper Tract Urothelial Carcinoma" [MeSH] OR UTUC OR "upper tract urothelial cancer") AND ("Kidney Sparing Surgery" OR "nephron sparing" OR "segmental ureterectomy" OR "endoscopic management") AND ("high risk" OR "high-grade" OR invasive) AND (outcomes OR survival OR "renal function"). In Scopus, the following query was used: TITLE-ABS-KEY (upper AND tract AND urothelial) AND TITLE-ABS-KEY (kidney AND sparing OR nephron AND sparing) AND TITLE-ABS-KEY (high-risk OR high-grade) AND TITLE-ABS-KEY(outcome OR survival OR renal). For Embase, the search strategy consisted of ('upper tract urothelial carcinoma'/exp AND 'kidney sparing surgery'/exp AND 'high risk'/exp AND (outcome OR survival OR renal)). Reference lists of relevant review articles and clinical guidelines were manually screened to identify additional eligible studies.

Study selection and data extraction were performed independently by two reviewers. Titles and abstracts were screened first, followed by full-text review of potentially eligible studies. Extracted data included study characteristics, patient demographics, definitions of high-risk disease, treatment details, follow-up duration, oncological outcomes, renal function outcomes, and reported complications. Study quality was assessed using appropriate tools for observational and randomized studies, and findings were synthesized narratively, with quantitative pooling performed when data were sufficiently comparable.

Data were synthesized using a narrative approach, as quantitative meta-analysis was not performed due to heterogeneity across studies in patient selection, definitions of high-risk upper tract urothelial carcinoma, surgical techniques, and outcome reporting, which precluded reliable statistical pooling. Effect measures reported in the original studies, including hazard ratios, odds ratios, survival and recurrence rates, and changes in estimated glomerular filtration rate, were extracted and compared descriptively, with emphasis on the direction and consistency of effects between kidney-sparing surgery and radical nephroureterectomy. Results from previously published meta-analyses were cited for contextual comparison but were not re-pooled or recalculated, and formal assessment of statistical heterogeneity or publication bias was not undertaken given the limited number and observational nature of the included studies.

Only retrospective cohort studies were identified because comparative prospective studies and randomized controlled trials evaluating KSS versus RNU in high-risk UTUC are currently lacking. This is likely related to the rarity of UTUC, the ethical challenges of randomizing patients between nephron-preserving approaches and radical surgery, and the strong influence of patient and tumor characteristics on treatment selection. Therefore, available evidence is predominantly derived from retrospective observational cohorts.

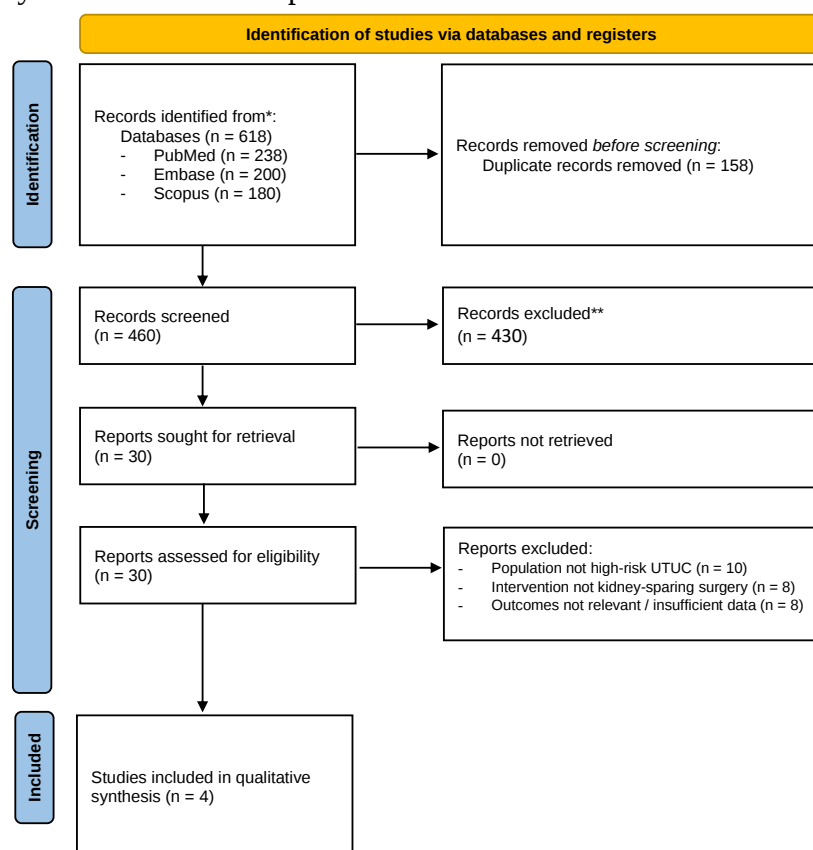


Figure 1. PRISMA 2020 flow diagram illustrating the identification, screening, eligibility, and inclusion of studies evaluating kidney-sparing surgery compared with radical nephroureterectomy in patients with high-risk upper tract urothelial carcinoma

RESULTS

Study Selection and Characteristics

A total of four observational studies were included and are summarized in Table 1. All included studies were retrospective cohort analyses comparing kidney-sparing surgery (KSS) with radical nephroureterectomy (RNU) in patients with high-risk upper tract urothelial carcinoma (UTUC). The studies comprised both population-based database analyses and single-center cohorts, several of which employed propensity-score matching to minimize baseline differences between treatment groups. High-risk UTUC was primarily defined by high-grade histology and/or muscle-invasive disease ($\geq pT2$). KSS modalities included segmental ureterectomy as well as endoscopic or percutaneous approaches, while RNU performed via open, laparoscopic, or robotic techniques served as the comparator. Across the included studies, oncologic outcomes such as overall survival, cancer-specific survival, recurrence-free survival, and metastasis-free survival were generally comparable between KSS and RNU in carefully selected patients. In contrast, renal functional outcomes consistently favored KSS, demonstrating smaller declines in estimated glomerular filtration rate compared with RNU.

Table 1. Characteristics and key outcomes of included studies (high-risk UTUC patients treated with KSS vs. RNU)

Study (Author, Year)	Design	High-Risk Definition	KSS Modality	Comparator	Follow-up	Oncologic Outcomes (KSS vs RNU)	Renal Outcomes
Ślusarczyk et al., (2024)	Retrospective, SEER database (USA); PSM cohort for SU vs RNU	High-grade and/or muscle-invasive (pT2–pT4); subgroup analysis of high-risk	Segmental ureterectomy (SU, open surgical)	RNU (standard)	Median ~50 months	CSS/OS: No difference in 5-year CSS or OS between SU and RNU (even for high-grade, $\geq pT3$ tumors, $p > 0.05$).	Renal: All patients retained contralateral kidney; SU preserved affected kidney. (Renal function metrics not reported in SEER analysis.)
Moore et al., (2025)	Retrospective cohort (single-center, USA)	High-grade UTUC (biopsy proven)	Endoscopic ablation (URS laser) in 14 pts; Segmental ureterectomy in 2 pts	RNU (open or robotic)	Median 36 months (2015–2021)	Survival: 5-yr OS ~60% in KSS vs ~55% in RNU (difference n.s.); 3-yr	Renal: Mean eGFR decline was –6.8 mL/min in KSS vs –21.1 mL/min in RNU ($p =$

Study (Author, Year)	Design	High-Risk Definition	KSS Modality	Comparator	Follow-up	Oncologic Outcomes (KSS vs RNU)	Renal Outcomes
						metastasis-free survival similar. Recurrence: 3-yr RFS no significant difference (higher local recurrence in KSS, but not statistically significant in this small sample).	0.11), indicating a trend toward better renal preservation with KSS (not statistically significant due to small N).
Büttner et al. (2025)	Retrospective cohort (single-center, Germany); Propensity-matched (46 KSS vs 46 RNU)	High-risk UTUC (mixed grades; included some high-grade cases)	Mix of open segmental resections and endoscopic KSS	RNU (open or laparoscopic)	Median 24 months	Oncologic: No significant difference in CSS or disease-free survival between KSS and RNU (median CSS similar, $p = 0.8$).	Renal: Early postoperative eGFR change: KSS +0.5 mL/min vs RNU -4.3 mL/min ($p = 0.015$), demonstrating significantly better renal function preservation with KSS.
Hendriks et al. (2022)	Retrospective cohort (single-center), propensity-weighted	Mixed risk (included ~50% high-risk cases)	URS ablation, percutaneous resection, segmental ureterectomy	Radical nephroureterectomy (RNU).	60 months.	5-yr CSS: 86% (KSS) vs 84% (RNU); 5-yr OS: 76% vs 76% (no significant difference)	No significant eGFR decline at 2 and 5 years in KSS vs RNU.

Abbreviations: SEER = Surveillance, Epidemiology, and End Results database; PSM = propensity score matched; SU = segmental ureterectomy; URS = ureteroscopy; RFS = recurrence-free survival; n.s. = not significant

As shown in Table 1, most studies defined high-risk UTUC primarily by the presence of high-grade pathology or invasive tumor stage. Several studies included mixed-risk populations but reported outcomes for high-risk subgroups separately (Ślusarczyk et al., 2024).

Kidney-sparing surgery (KSS) approaches varied across studies, with many focusing on segmental ureterectomy (SU), particularly for ureteral tumors, while others reported outcomes of endoscopic management, mainly flexible ureteroscopy with laser ablation and, less commonly, percutaneous resection. In several series, KSS was performed predominantly for imperative indications, such as a solitary kidney or baseline renal impairment, whereas other studies included elective KSS in patients with bilateral kidneys when tumors were considered suitable for conservative management.

Baseline tumor characteristics were frequently more favorable in KSS groups compared with radical nephroureterectomy (RNU) groups. In the largest included meta-analysis, patients undergoing KSS were significantly less likely to present with hydronephrosis and more likely to have lower-grade or lower-stage tumors than those treated with RNU (Zhou, Huang, Sun, Ning, & Tang, 2025). This reflects inherent selection bias in treatment allocation. Notably, Ślusarczyk et al. (2024) performed propensity score matching for SU versus RNU, balancing key variables such as tumor stage, grade, size, and patient age, thereby enabling more reliable comparisons of oncological outcomes (Ślusarczyk et al., 2024).

Table 2. Summary of Comparative Outcomes Between Kidney-Sparing Surgery (KSS) and Radical Nephroureterectomy (RNU)

Outcome	Findings from Included Studies	Interpretation
Cancer-specific survival (CSS)	No significant difference between KSS and RNU. Five-year CSS was approximately 70–75% in Ślusarczyk et al. (2024), while Hendriks et al. (2022) reported 86% for KSS and 84% for RNU.	KSS provides comparable cancer-specific survival in carefully selected high-risk UTUC patients.
Overall survival (OS)	Comparable survival outcomes were observed between groups. Hendriks et al. reported 5-year OS of 76% for both KSS and RNU, while Moore et al. reported approximately 60% vs 55% (p=0.8).	Available evidence does not demonstrate survival disadvantage with KSS when appropriate patient selection is applied.
Progression and metastasis-free survival	No significant differences in progression-free, metastasis-free, or disease-specific outcomes were reported between KSS and RNU.	Tumor biology appears to be a more important determinant of progression than surgical approach alone.
Ipsilateral upper tract recurrence	Recurrence was consistently higher after KSS, particularly after endoscopic management. Endoscopic KSS showed higher recurrence risk compared with RNU (OR≈39).	KSS requires strict surveillance due to increased local recurrence risk.
Bladder recurrence	Similar rates of intravesical recurrence were observed between KSS and RNU.	Bladder recurrence appears related to urothelial field effects rather than surgical modality.
Salvage RNU	Approximately 20–30% of patients initially treated with KSS required delayed RNU due to recurrence or progression.	Delayed RNU can be performed without clear adverse impact on survival when surveillance is adequate.
Renal function preservation	KSS demonstrated smaller declines in eGFR. Moore et al. reported eGFR decline of 7 mL/min after KSS versus 21 mL/min	KSS provides superior preservation of renal function compared with RNU.

Outcome	Findings from Included Studies	Interpretation
Perioperative complications	after RNU. Büttner et al. reported stable eGFR after KSS (+0.5 mL/min) compared with a decline after RNU (−4.3 mL/min, $p=0.015$). Findings were inconsistent. Moore et al. reported fewer severe complications with KSS, whereas Büttner et al. reported higher major complications in KSS (30% vs 6%).	Complication rates vary according to KSS technique and patient selection.
Procedure burden	KSS required more repeated interventions, particularly endoscopic procedures (3.3 vs 2.1 procedures under anesthesia).	The benefit of renal preservation must be balanced against repeated procedures and surveillance requirements.
Hospital stay and quality of life	Hospital stay was generally comparable. Formal QoL comparisons were limited.	Further studies are needed to evaluate patient-centered outcomes.

Across the included studies, oncological outcomes were generally comparable between KSS and RNU in selected high-risk UTUC patients (Table 2). No significant differences were observed in cancer-specific survival, overall survival, progression-free survival, or metastasis-free survival. In the SEER-based analysis by Ślusarczyk et al. (2024), five-year CSS was similar between segmental ureterectomy and RNU, including patients with high-grade or muscle-invasive disease. Similarly, Hendriks et al. (2022) reported comparable five-year CSS (86% vs 84%) and OS (76% vs 76%) between KSS and RNU after propensity-score adjustment. Moore et al. (2025) also found no significant difference in five-year OS between KSS and RNU (60% vs 55%, $p=0.8$). However, recurrence patterns differed between treatment approaches. KSS was associated with a higher risk of ipsilateral upper tract recurrence, particularly following endoscopic management. The increased recurrence risk emphasizes the importance of strict surveillance protocols and appropriate patient selection. Despite higher local recurrence rates, available studies did not demonstrate inferior metastasis-free survival or overall survival among patients managed with KSS.

DISCUSSION

Principal Findings

This systematic review demonstrates that, in carefully selected patients with high-risk UTUC, kidney-sparing surgery (KSS) can achieve long-term oncological outcomes comparable to those of radical nephroureterectomy (RNU), without compromising cancer-specific or overall survival (Ślusarczyk et al., 2024; Zhou et al., 2025). These findings challenge the traditional paradigm that high-grade or invasive UTUC uniformly requires radical surgery. Rather, they suggest that the biological behavior of the tumor and the appropriateness of patient selection may be more important determinants of outcome than the

extent of surgical resection alone. When applied to selected patients, KSS offers the dual advantage of effective cancer control and preservation of renal function while avoiding the morbidity associated with nephrectomy (Rouprêt et al., 2018). A central observation of this review is that patient selection is critical to the success of kidney-sparing approaches in high-risk disease. KSS should not be considered a universal alternative to RNU but rather a tailored option for patients whose tumors exhibit favorable characteristics or in whom renal preservation is clinically imperative. The available evidence indicates that, when such selection criteria are met, KSS can provide durable oncological control while maintaining renal reserve, which is particularly relevant in an older population with frequent baseline renal impairment (Masson-Lecomte et al., 2025).

The principal trade-off associated with KSS is a substantially higher risk of local recurrence within the preserved upper urinary tract (Zhou et al., 2025). Importantly, however, this increased local recurrence rate did not translate into inferior survival outcomes in the studies reviewed. This suggests that many recurrences are either detected early through intensive surveillance or remain amenable to secondary interventions, including endoscopic management or timely salvage RNU. These findings underscore that successful implementation of KSS in high-risk UTUC is inseparable from rigorous follow-up protocols and patient compliance. Taken together, the data support a paradigm shift toward more individualized management of high-risk UTUC. While RNU remains the standard of care for many patients, KSS may represent a viable alternative in selected cases, provided that patients are carefully chosen and closely monitored. This balance between oncological safety and functional preservation represents a key consideration in contemporary UTUC management.

Patient Selection Criteria for Kidney-Sparing Surgery in High-Risk UTUC

Based on the available evidence and current clinical guidelines, kidney-sparing surgery (KSS) should be considered in high-risk UTUC only for carefully selected patients in whom the potential benefits of renal preservation outweigh the oncological risks. These scenarios generally fall into a limited number of well-defined clinical contexts. Imperative indications related to renal function remain the strongest justification for KSS in high-risk disease. Patients with a solitary kidney, bilateral UTUC, or advanced pre-existing chronic kidney disease represent situations in which radical nephroureterectomy (RNU) would result in dialysis dependence or substantial morbidity (Masson-Lecomte et al., 2024; Rouprêt et al., 2018). In such cases, even high-grade tumors may be managed with KSS out of necessity, with the understanding that the risk of local recurrence is higher. Consistent with this, the EAU guidelines acknowledge that ureterorenoscopy with laser ablation or segmental ureterectomy

may be considered on a case-by-case basis for high-risk tumors when imperative kidney-sparing indications are present, despite an increased risk of progression (Masson-Lecomte et al., 2024).

Tumor location is another critical determinant of suitability for KSS. High-risk tumors confined to the distal ureter are particularly amenable to kidney-sparing approaches, as distal ureterectomy with ureteroneocystostomy can achieve complete oncological excision with negative margins while preserving the kidney. Several studies report comparable cancer outcomes between distal ureterectomy and RNU for selected high-risk distal ureter tumors, and this approach is endorsed by the EAU in highly selected cases (Masson-Lecomte et al., 2024). In contrast, high-risk tumors involving the renal pelvis or proximal ureter are less suitable for KSS, given the difficulty of achieving adequate margins and the higher risk of understaging and recurrence associated with segmental resection in these locations (Masson-Lecomte et al., 2024).

Multiple studies indicate that long-term oncologic outcomes for kidney-sparing surgery (KSS) are comparable with those of radical nephroureterectomy (RNU). A recent meta-analysis including over 33 000 patients found no significant difference in 5-year cancer-specific survival (CSS) or overall survival (OS) between segmental ureterectomy and RNU, and hazard-ratio analyses likewise showed no difference in 5-year OS or CSS (Calvillo-Ramirez et al., 2025; Zhou et al., 2025). In a multicenter French series of distal ureterectomy, 91% of whom were high-risk, the 5-year CSS reached 84.4% and OS 71.9% (Masson-Lecomte et al., 2022). Tumor location strongly influences outcomes: distal ureterectomy with ureteroneocystostomy for high-risk tumors confined to the distal ureter yields oncologic results comparable to RNU and low ipsilateral recurrence (0–18%), whereas segmental resection of the proximal ureter or purely endoscopic ablation is associated with higher failure and recurrence rates (Masson-Lecomte et al., 2024).

Consequently, KSS should be reserved for carefully selected high-risk patients. Current EAU guidelines recommend distal ureterectomy only for high-risk tumors limited to the distal ureter (Masson-Lecomte et al., 2024). Ureterorenoscopy or segmental ureterectomy may be considered for high-risk patients with low-grade disease lacking infiltrative features on imaging, and tumor size or multifocality alone should not automatically mandate RNU (Masson-Lecomte et al., 2024). Imperative indications such as a solitary kidney, bilateral UTUC, or severe chronic kidney disease may justify KSS even for high-grade tumors (Masson-Lecomte et al., 2024). Ideal candidates have unifocal lesions <2 cm, preferably located in the distal ureter, negative cytology and no radiographic muscle invasion, and must commit to

rigorous surveillance, including early second-look ureteroscopy (Masson-Lecomte et al., 2024). Endoscopic management requires strict follow-up and is prone to higher local recurrence and repeated interventions, whereas segmental ureterectomy offers better oncologic control and superior renal function preservation (Calvillo-Ramirez et al., 2025; Masson-Lecomte et al., 2024). Although cost data are limited, preserving renal function may reduce dialysis-related healthcare expenses.

Tumor grade and stage must also be interpreted in a nuanced manner. While high-grade histology defines high-risk disease, not all high-grade tumors demonstrate aggressive behavior on imaging. In selected cases where high-grade tumors appear small, unifocal, non-invasive, and lack radiographic signs of muscle invasion or hydronephrosis, a conservative approach may be considered in experienced centers (Masson-Lecomte et al., 2024). For example, a high-grade UTUC less than 2 cm in size, unifocal, and confined to the urothelium may be amenable to endoscopic management or segmental resection. Nevertheless, current recommendations emphasize that KSS for high-risk UTUC should generally be limited to distal ureteral lesions or imperative cases, as tumors of the renal pelvis or those with invasive features carry a high risk of understaging and progression and are best managed with RNU (Khene et al., 2016).

Patient-related factors, including comorbidity burden and surgical fitness, further influence treatment selection. In patients with advanced age or significant comorbidities who are poor candidates for major surgery, KSS may represent a pragmatic alternative to RNU, even if oncological control may be less definitive. Several studies included older patients or those with higher anesthetic risk in the KSS cohorts, reflecting real-world decision-making where treatment must be individualized (Büttner et al., 2025).

Patient consent and compliance with intensive surveillance are essential prerequisites for KSS. All major guidelines emphasize that kidney-sparing approaches require strict follow-up protocols, including frequent ureteroscopic evaluation, urine cytology, and cross-sectional imaging. Patients who are unwilling or unable to adhere to such surveillance are poor candidates for KSS, as delayed detection of recurrence could compromise outcomes. In contrast, RNU largely eliminates the need for upper tract surveillance, limiting follow-up primarily to bladder monitoring (Ko et al., 2025).

In summary, optimal candidates for KSS in high-risk UTUC are those with imperative renal indications, selected distal ureteral tumors, limited tumor burden without radiographic invasion, acceptable surgical risk, and a clear understanding of and commitment to rigorous surveillance. Patients with large, multifocal, renal pelvic, or proximal ureter tumors, or clear muscle-invasive disease, remain best served by RNU in the absence of imperative indications.

Overall, our findings support an individualized, risk-adapted approach consistent with current guidelines, in which RNU remains the standard of care for most high-risk UTUC patients, while KSS may be safely offered to a carefully selected subset.

Oncological Outcomes and the Question of Compromise

A central concern in the management of high-risk UTUC is whether the use of kidney-sparing surgery (KSS) compromises oncological outcomes compared with immediate radical nephroureterectomy (RNU). Based on the findings of this systematic review, the available evidence suggests that, when patients are appropriately selected and closely managed, KSS does not result in inferior cancer-specific or overall survival (Ślusarczyk et al., 2024). In matched and adjusted comparisons, survival outcomes were largely equivalent between KSS and RNU. This observation implies that KSS has generally been applied to a subset of high-risk patients whose disease remains biologically controllable (Kim et al., 2021; Paciotti et al., 2023).

Importantly, this equivalence should be interpreted in the context of inherent selection processes. Patients offered KSS in clinical practice tend to represent the lower-risk end of the high-risk spectrum, whereas those with clearly aggressive or bulky invasive disease are preferentially treated with RNU (Kenigsberg et al., 2020). As a result, outcomes between the two approaches converge. This nuance must be acknowledged: the available data do not support indiscriminate use of KSS in all high-risk UTUC. Rather, they indicate that, in the specific scenarios where KSS has been applied in the literature, survival has not been compromised. Applying KSS outside these carefully selected contexts, such as for large, invasive renal pelvic tumors would likely lead to inferior outcomes.

The nature of the evidence base limits the strength of these conclusions. All available studies are retrospective or registry-based, and no randomized controlled trials have directly compared KSS with RNU in high-risk UTUC. Although several studies employed multivariable adjustment or matching, residual confounding is likely. For instance, unmeasured differences in tumor extent or biological aggressiveness may have favored the KSS cohorts. Therefore, the observed equivalence in outcomes should not be overgeneralized beyond the selected populations studied.

Notably, oncological outcomes differed among KSS modalities. Segmental ureterectomy appears to provide more reliable cancer control than purely endoscopic management in high-risk disease. In the meta-analysis, segmental resection demonstrated outcomes comparable to RNU, whereas endoscopic management was associated with worse overall survival (hazard ratio approximately 1.4) and markedly higher rates of local recurrence

(Zhou et al., 2025). Segmental ureterectomy allows en bloc tumor removal with pathological margin assessment and, in some cases, lymph node evaluation, thereby offering greater oncological assurance. Endoscopic approaches, while maximally nephron-sparing, carry a higher risk of residual microscopic disease and are therefore less reliable in the setting of high-grade pathology. Nevertheless, endoscopic management may remain the only feasible option in imperative cases or in frail patients who cannot tolerate more extensive surgery.

Overall, our findings suggest that KSS does not inherently compromise oncological outcomes in high-risk UTUC when applied judiciously. Among kidney-sparing options, segmental ureterectomy particularly distal ureterectomy, appears preferable to endoscopic ablation whenever feasible, as it offers a more favorable balance between oncological control and renal preservation (Zhou et al., 2025).

Renal Function and Clinical Implications

The benefit of renal preservation observed in this review is clinically meaningful. Avoiding nephrectomy prevents the abrupt decline in glomerular filtration rate (GFR) and reduces the risk of progression to advanced chronic kidney disease or dialysis. While cancer-specific survival was similar between kidney-sparing surgery (KSS) and radical nephroureterectomy (RNU), one might hypothesize that preservation of renal function could confer advantages in overall survival (OS), given the well-established association between chronic kidney disease and cardiovascular morbidity. Although findings across included studies did not demonstrate a statistically significant OS benefit for KSS, some observational studies suggested a numerical trend toward improved OS, possibly reflecting better metabolic and physiological reserve in patients who avoid nephrectomy. For example, Moore et al. reported a numerically higher 5-year OS in the KSS group, although this difference was not statistically significant (Moore et al., 2025). It is conceivable that with larger sample sizes or longer follow-up, a modest OS benefit related to renal preservation may emerge, particularly in older or comorbid patients.

Preserved renal function also has important implications for systemic therapy. High-risk UTUC frequently warrants consideration of adjuvant platinum-based chemotherapy, especially in patients with advanced pathological stage or nodal involvement. However, a substantial proportion of patients become ineligible for cisplatin following RNU due to postoperative renal insufficiency. By maintaining renal reserve, KSS may allow a greater proportion of patients to remain eligible for effective systemic therapy. Although none of the included studies directly quantified this downstream benefit, it represents a clinically relevant consideration when counseling patients with high-risk disease.

From a patient-centered perspective, preservation of renal function is likely to translate into meaningful quality-of-life benefits. UTUC commonly affects older individuals with comorbidities such as diabetes or hypertension, in whom loss of renal mass may accelerate renal decline. Avoiding dialysis or severe CKD is a major advantage, even if it comes at the cost of more intensive surveillance and repeated interventions. Unfortunately, formal quality-of-life data comparing KSS and RNU remain scarce, highlighting an important gap in the literature.

Long-term renal outcomes beyond 5 years remain insufficiently characterized. Most studies included in this review reported follow-up durations of up to 3–5 years, limiting assessment of late progression to end-stage renal disease. Nevertheless, given the consistent differences in postoperative eGFR, it is reasonable to anticipate a higher long-term risk of renal failure among patients undergoing RNU, particularly those with marginal baseline renal function.

Limitations of Evidence and Risk of Bias

The overall quality of evidence supporting KSS in high-risk UTUC is moderate. A major limitation is the absence of randomized controlled trials; all available data derive from retrospective cohorts or registry-based analyses. The exclusive inclusion of retrospective cohort studies reflects the current state of evidence in high-risk UTUC management. Randomized controlled trials are difficult to perform because of the relatively low incidence of UTUC, heterogeneity in tumor characteristics, and ethical concerns regarding assigning patients with potentially aggressive disease to a kidney-sparing strategy. Consequently, treatment decisions are highly individualized, resulting in observational evidence as the primary source of comparative data.

CONCLUSION

In high-risk upper tract urothelial carcinoma (UTUC), kidney-sparing surgery (KSS) can be a safe and effective alternative to radical nephroureterectomy (RNU) when applied to a carefully selected subset of patients. Current evidence indicates that KSS is most appropriate for patients with distal ureteral tumors or small, unifocal lesions amenable to complete endoscopic or segmental resection, as well as for those with imperative indications for nephron preservation such as a solitary kidney, bilateral disease, or pre-existing chronic kidney disease. Among patients who meet these stringent selection criteria, five-year cancer-specific and overall survival rates range from approximately 70% to 86% and are not significantly different from those achieved with RNU. In contrast, these outcomes should not be extrapolated to

patients with large, multifocal, renal pelvic, or proximal ureter tumors, or with overt muscle-invasive disease, for whom radical nephroureterectomy remains the standard of care.

Overall, these findings support a personalized, risk-adapted treatment strategy in high-risk UTUC, in which kidney-sparing approaches represent an evolution of care rather than a compromise of oncological safety in appropriately selected patients. Future prospective studies and the integration of advanced imaging, molecular biomarkers, and improved risk stratification tools are needed to refine patient selection further and optimize long-term outcomes.

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