REVIEW ARTICLE

Translational Health Reports. 2026; 2(1): 12
https://doi.org/10.22034/thr.2025.563719.1031

Current Insights into Pathophysiology, Clinical Presentation, and Minimally Invasive Management of Renal Peripelvic Cysts, A Narrative Review

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Article history:

Received: 28 Sep 2025
Accepted: 11 Dec 2025
Available online: 19 Dec 2025

Keywords:

Peripelvic cyst
Parapelvic cyst
Retroperitoneoscopic decortication
Ureteroscopic drainage
IL-6
TNF-α
Renal cyst management

Abstract

Background: Renal peripelvic (parapelvic) cysts cause hydronephrosis, pain, and obstruction when exceeding 4-5 cm due to hilar compression, with elevated IL-6, TNF-α, and creatinine reflecting inflammation and impaired function.
Objective: This narrative review synthesizes evidence on pathophysiology, diagnosis, and minimally invasive management, emphasizing retroperitoneoscopic decortication versus ureteroscopic drainage outcomes.
Methods: Literature from 2011-2025 (PubMed, Scopus, Web of Science) was reviewed, prioritizing comparative studies, case series (n≥20), and biomarker data; a key 100-patient cohort provided head-to-head analysis.
Results: Retroperitoneoscopic decortication shows superior outcomes versus ureteroscopy: shorter operative time (78±18 vs 112±24 min), less blood loss (25±15 vs 55±30 mL), faster recovery (hospital stay 2.8±0.9 vs 5.1±1.4 days), lower complications (8% vs 18%), and greater IL-6/TNF-α decline; recurrence rates similar (8-10%).
Conclusion: Retroperitoneoscopic decortication is optimal for symptomatic peripelvic cysts, balancing efficacy, safety, and biomarker recovery over ureteroscopy.

Cite this article as: Bagheri Sh, Rezaeimehr B, Yousefi zoshk M, Maboudi M, Abdollahi A, Younesi Rostami M, Bay MJ, Deylami A. Current Insights into Pathophysiology, Clinical Presentation, and Minimally Invasive Management of Renal Peripelvic Cysts, A Narrative Review. Transl Health Rep. 2026; 2(1):12. https://doi.org/10.22034/thr.2025.563719.1031.

Introduction

Renal cysts represent the most common structural kidney abnormality and typically remain asymptomatic [1,2]. However, growth and compression of blood vessels, urinary tract, or adjacent tissues can produce hematuria, flank pain, or other symptoms [1,2]. Renal peripelvic cysts warrant particular attention, as their size correlates with biomarker elevations—serum creatinine and BUN reflect obstruction-related dysfunction, while IL-6 and TNF-α indicate inflammatory activation in symptomatic cases [1,2].

These cysts originate near the renal hilum, often evolving from simple cysts into the renal sinus [3,4]. Small cysts (<4 cm) lack specific manifestations and require only surveillance, but larger lesions compress pelvicalyceal systems and hilar vessels, causing hydronephrosis, pain, or infection [5].

Treatment mirrors general renal cyst management: observation suffices for asymptomatic cases, but intervention becomes necessary for cysts >4 cm or those producing secondary effects [6,7]. Options include ultrasound-guided aspiration [6] or cyst decortication

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(cyst removal surgery) [7], both aiming to decompress, alleviate obstruction, and minimize recurrence [8]. Peripelvic location complicates complete exposure due to proximity to renal vessels, pelvis, and ureter; incomplete aspiration predisposes to early recurrence [9,10]. Decortication—resection of cyst wall with peripelvic fat flap packing—offers durable results with lower reaccumulation [11,12].

Traditional open surgery provides reliable decortication but incurs large incisions, substantial blood loss, prolonged recovery, and patient dissatisfaction [13]. Laparoscopic techniques have matured significantly, establishing themselves as the gold standard for renal cystic disease [14]. These approaches deliver smaller incisions, reduced bleeding, minimal trauma, rapid recovery, and low infection risk [15,16], earning broad acceptance among patients and urologists—primarily for simple cysts, with growing peripelvic application [17,18].

Methods

This narrative review was conducted by synthesizing contemporary peer-reviewed literature on renal peripelvic (parapelvic) cysts published between 2011 and 2025, sourced from PubMed, Scopus, Web of Science, and Google Scholar using the search terms "parapelvic cyst," "peripelvic cyst," "retroperitoneoscopic decortication," "laparoscopic renal cyst unroofing," "flexible ureteroscopic drainage," and "holmium laser cyst incision" alone or in combination. Additional references were identified through cross-referencing of retrieved articles and recent conference abstracts. Priority was given to comparative studies, large case series ($n \geq 20$), and publications reporting perioperative outcomes, complication rates, recurrence, and biomarker data (IL-6, TNF-α, serum creatinine). The primary unpublished comparative cohort of 100 patients was incorporated as the most detailed head-to-head analysis currently available. Levels of evidence were not formally graded, as the narrative format aimed to provide a comprehensive, clinically oriented synthesis rather than a systematic review with meta-analysis.

Pathophysiology and Biomarker Correlation

The precise pathogenesis of renal peripelvic (parapelvic) cysts is still not fully elucidated, but several mechanisms have been proposed. Most authorities consider these lesions to arise from lymphatic ectasia or obstruction of pericalyceal lymphatics, with contributions from embryonic remnants of the wolffian duct system or persistent lymphatic–venous connections [3,4]. Capuano et al. emphasized that parapelvic cysts may represent an imaging marker of underlying genetic or acquired tubular dysfunction in some cases, although the vast majority remain sporadic and benign [3]. Nikoobakht and co-workers described a case of massive hilar encasement mimicking a neoplastic process, underscoring the complex anatomical relationships in this region [4].

As the cyst enlarges beyond 4–5 cm, extrinsic compression of the renal pelvis, infundibula, and hilar vessels produces upstream obstruction, progressive hydronephrosis, and, in prolonged cases, parenchymal atrophy [1,2,5]. This mechanical effect is reflected clinically by rising serum creatinine and blood urea nitrogen, as well as segmental impairment of renal perfusion detectable on functional imaging [1,2].

Beyond mechanical obstruction, a growing body of evidence highlights a significant inflammatory component. Symptomatic peripelvic cysts are frequently accompanied by elevated circulating levels of interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and C-reactive protein, suggesting chronic low-grade inflammation triggered by repeated micro-ischemia, endothelial activation, or subclinical infection [20]. Chen et al. demonstrated in experimental models that acute kidney injury and chronic compressive insults lead to sustained release of these cytokines via NF-κB pathways in tubular and interstitial cells [20]. In the clinical cohort reported by Tang et al., baseline IL-6 and TNF-α were significantly higher in symptomatic patients than in age-matched controls, and successful surgical decompression produced a rapid and sustained decline in these markers—more pronounced after retroperitoneoscopic decortication than after ureteroscopic drainage—providing objective evidence that the laparoscopic approach induces less perioperative inflammatory stress and permits earlier restoration of normal renal perfusion.

Diagnostic Evaluation

Ultrasonography is the initial screening modality of choice because it is widely available, non-ionizing, and highly sensitive for detecting cystic lesions adjacent to the renal sinus. However, ultrasound alone cannot reliably distinguish true parapelvic cysts from hydronephrosis, extrarenal pelvis, calyceal diverticula, or hilar masses [3,4]. Multi-phase contrast-enhanced CT or MR urography is therefore considered mandatory for definitive characterization. Typical imaging features include a well-circumscribed, water-attenuation (CT) or T2-hyperintense (MRI) lesion centered in the renal sinus, exerting mass effect on the pelvicalyceal system without intraluminal filling defects and without enhancement of the cyst wall [3,4]. Intravenous urography or CT urography may show the classic "spreading" or "splaying" of the collecting system with

delayed excretion on the affected side, confirming extrinsic compression rather than intrinsic obstruction.

Evolution of Surgical Management

Open Decortication

For decades, open retroperitoneal or transperitoneal decortication with pedicled omental or perinephric fat flap interposition represented the gold-standard definitive therapy [11,12,23]. The technique permits complete excision of the cyst wall down to within 0.5 cm of the renal parenchyma while preserving the integrity of the collecting system and allows direct inspection and treatment of concomitant pathology. Kobayashi et al. and Topaktas et al. reported long-term recurrence rates below 5 % with this approach [11,12]. Nevertheless, the procedure is associated with large flank incisions (12–20 cm), substantial blood loss (200–500 mL), prolonged ileus, hospital stays of 7–10 days, and conspicuous scarring—drawbacks that have driven the shift toward minimally invasive alternatives [13,24].

Retroperitoneoscopic Laparoscopic Decortication

The posterior retroperitoneal approach has become the preferred minimally invasive technique for peripelvic cysts because it provides direct, extraperitoneal access to the renal hilum, avoids bowel manipulation, and minimizes postoperative ileus and adhesion formation [14–16,18,25,29]. Contemporary series describe a standardized three- or four-port technique with balloon dilation of the retroperitoneal working space. After mobilization of the kidney and identification of the cyst, the wall is excised circumferentially 0.5–1 cm away from the renal parenchyma under magnified vision; the residual cavity is usually marsupialized and filled with perinephric fat, oxidized cellulose, or fibrin glue to prevent recurrence. Zhu et al., Akkoç et al., Han et al., Ma et al., and Ueki et al. collectively report mean operative times of 60–110 minutes, estimated blood loss <50 mL, time to oral intake <24 hours, and discharge within 2–4 days, with complication rates of 4–10 % and recurrence rates of 0–8 % at 2–5 years [14–16,18,29]. The original comparative series by Tang et al. confirmed these perioperative advantages in the specific peripelvic population.

Flexible Ureteroscopic Internal Drainage

Flexible ureteroscopy with holmium:YAG laser incision and creation of a wide cysto-pelvic communication has been promoted as the ultimate "scarless" option and is particularly appealing when concomitant calyceal stones are present [5,17,21,22]. The cyst wall typically appears as a pale blue-purple bulging dome within the renal pelvis. Huang et al., Shen et al., Wang et al., and Wen et al. described success rates of 85–95 % with operative times of 90–150 minutes [5,17,21,22]. However, technical challenges include precise localization of the thinnest wall segment, risk of thermal injury to the pelvic urothelium, incomplete drainage if the incision is too small, and potential long-term stricture formation. Reported complication rates range from 10–25 %, including bleeding requiring transfusion, pelvic perforation, and postoperative sepsis [5,22].

Comparative Outcomes and Biomarker Insights

The most comprehensive direct comparison to date comes from the 100-patient cohort (50 retroperitoneoscopic vs. 50 ureteroscopic) reported by Tang and colleagues. Statistically and clinically significant advantages of the retroperitoneoscopic approach included:

Operative time: 78 ± 18 min vs. 112 ± 24 min ($P < 0.001$)

Estimated blood loss: 25 ± 15 mL vs. 55 ± 30 mL ($P < 0.001$)

Time to first flatus: 18 ± 6 h vs. 32 ± 10 h ($P < 0.001$)

Postoperative ambulation: 1.2 ± 0.4 days vs. 2.5 ± 0.8 days ($P < 0.001$)

Length of hospital stay: 2.8 ± 0.9 days vs. 5.1 ± 1.4 days ($P < 0.001$)

Analgesic requirement: 24 % vs. 58 % ($P = 0.002$)

Overall complication rate: 8 % vs. 18 % ($P = 0.031$)

Biomarker analysis added a novel dimension: serum IL-6 and creatinine declined more rapidly and to lower nadir levels at 1 week and 1 month in the laparoscopic group, indicating reduced surgical trauma, less inflammatory activation, and earlier recovery of renal perfusion. Recurrence rates at 6–24 months were comparable (laparoscopic 8 % vs. ureteroscopic 10 %, $P > 0.05$), suggesting that both techniques are durable when performed adequately [32]. These results corroborate broader meta-analyses favoring laparoscopic over open surgery [13,24] and provide the first biomarker-supported evidence of physiological superiority of retroperitoneoscopic decortication in the peripelvic subset.

Complications and Recurrence Risk

Complications of retroperitoneoscopic decortication are generally minor (Clavien–Dindo grade ≤ 2) and include transient CO_2 retention, vascular injury requiring hemostatic agents, collecting-system entry managed with drainage, urine leak, and retroperitoneal hematoma [14–16,29]. Ureteroscopic internal drainage carries distinct risks such as ureteral avulsion, pelvic or calyceal perforation, postoperative pyelonephritis, and late stricture of the cysto-pelvic communication [5,22]. Recurrence is primarily related to incomplete wall

excision or inadequate marsupialization in laparoscopic cases and to insufficient incision size or fibrosis of the drainage ostium in ureteroscopic cases; deep hilar location and complex vascular anatomy remain the strongest predictors regardless of approach [32].

Discussion

Peripelvic cysts manifest across all age groups but show increased prevalence after age 50, with no significant gender disparity [19,20]. These non-heritable benign lesions typically remain asymptomatic in early stages when small, warranting only regular surveillance [21]. However, cysts exceeding 4 cm compress the renal collecting system and pedicle vessels, producing obstructive symptoms, hydronephrosis, and potential complications that necessitate timely surgical intervention [22].

Traditional open decortication offers technical maturity and permits concomitant pathology management but carries substantial drawbacks [23]. Large incisions lead to delayed wound healing, prolonged hospital stays, increased pain, and greater infection risk [24]. In contrast, laparoscopic approaches provide magnified visualization of renal, cyst, fascial, and vascular anatomy [25]. Multiple studies confirm laparoscopy reduces operative trauma, intraoperative bleeding, surgical duration, accelerates wound healing, and lowers postoperative complications compared to open surgery [26,27].

Direct comparative data (Tang et al., n=100) demonstrate retroperitoneoscopic superiority over ureteroscopic drainage: operative time 78±18 vs 112±24 minutes ($P<0.001$), blood loss 25±15 vs 55±30 mL ($P<0.001$), time to flatus 18±6 vs 32±10 hours ($P<0.001$), ambulation 1.2±0.4 vs 2.5±0.8 days ($P<0.001$), hospital stay 2.8±0.9 vs 5.1±1.4 days ($P<0.001$), analgesic requirements 24% vs 58% ($P=0.002$), and complications 8% vs 18% ($P=0.031$) [28]. The retroperitoneoscopy cohort showed more rapid IL-6, TNF-α, and creatinine normalization, indicating reduced systemic inflammation and faster renal perfusion recovery versus ureteroscopy.

Retroperitoneal access avoids intraperitoneal contamination, simplifies exposure, and better matches peripelvic cyst anatomy, yielding superior safety [29]. Lower complication profiles derive from minimal incision size and tissue exposure [30,31]. Serum creatinine and IL-6 monitoring provides objective assessment of treatment response and long-term prognosis. Recurrence rates proved equivalent (8% vs 10%, $P>0.05$), though deep hilar positioning or complex vascular anatomy elevates risk across approaches—underscoring surgeon proficiency as the critical determinant of durable outcomes [32].

Conclusion

Retroperitoneoscopic laparoscopic decortication has established itself as the current optimal treatment for symptomatic renal peripelvic cysts, offering significantly shorter operative time, reduced blood loss, faster recovery, lower complication rates, and a more favorable postoperative inflammatory profile (rapid decline in IL-6, TNF-α, and serum creatinine) compared with flexible ureteroscopic internal drainage. Although ureteroscopic drainage remains a useful scarless alternative in selected patients—particularly those with concomitant stones or contraindications to general anaesthesia—the retroperitoneal laparoscopic approach provides the best balance of efficacy, safety, and physiological recovery for the majority of cases. With accumulating experience, refinement of technique, and emerging biomarker-guided assessment, retroperitoneoscopic decortication is likely to remain the preferred standard in the management of this challenging subset of renal cystic disease.

Acknowledgment

The authors would like to express their appreciation to all those who helped us conduct this research.

Funding

None

Authors Contributions

The authors contributed to the data analysis. Drafting, revising and approving the article, responsible for all aspects of this work.

Conflict of Interest

None

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