

Management strategies and outcomes of iatrogenic ureteral injury according to the timing of diagnosis: a retrospective single-center study

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Abstract

Background

Iatrogenic ureteral injury is a rare but clinically significant complication of pelvic and abdominal surgery. Although early recognition is considered important, differences in management strategies according to the timing of diagnosis have not been fully characterized. This study compared management strategies and clinical outcomes between intraoperatively and postoperatively diagnosed iatrogenic ureteral injuries.

Methods

We retrospectively reviewed patients with iatrogenic ureteral injury identified at our institution between January 2000 and December 2025. Patients with insufficient clinical data were excluded. Patients were categorized into intraoperative and postoperative diagnosis groups. Clinical characteristics, management strategies, and long-term outcomes were compared. Categorical variables were analyzed using Fisher's exact test, and between-group comparisons were considered exploratory because of the limited sample size.

Results

Among 35 patients identified from electronic medical records, 11 were excluded because of insufficient clinical data, leaving 24 patients for analysis. Fifteen patients (62.5%) were diagnosed intraoperatively and 9 (37.5%) postoperatively. Definitive repair during the index surgery was more frequent in the intraoperative diagnosis group than in the postoperative diagnosis group (86.7% vs. 22.2%, $p = 0.003$). Ureteral stents were also used more frequently in the intraoperative group (93.3% vs. 44.4%, $p = 0.015$), whereas nephrostomy was more frequent in the postoperative group (6.7% vs. 44.4%, $p = 0.047$). No statistically significant differences were observed in recurrent stricture, permanent ureteral stenting, permanent nephrostomy, functional loss of the affected kidney, or final urological outcome.

Conclusions

In this retrospective single-center cohort, intraoperative diagnosis was associated with more frequent definitive repair during the index surgery, whereas postoperative diagnosis was associated with greater use of nephrostomy. Long-term urological outcomes did not differ significantly between the groups. These findings should be interpreted cautiously because of the limited sample size and retrospective study design, and larger multicenter studies are warranted.

Background

Iatrogenic ureteral injury is an uncommon but potentially serious complication of abdominal and pelvic surgery. It may occur during gynecological, colorectal, urological, and other surgical procedures and can result in urinary leakage, ureteral obstruction, infection, loss of renal function, and the need for additional

interventions [1, 2]. Because the clinical presentation and subsequent management vary according to the site and extent of injury and the timing of recognition, appropriate diagnosis and management remain important clinical challenges [1] .

Recognition of ureteral injury during the index surgery may permit immediate assessment and definitive repair, whereas injuries identified postoperatively may require ureteral stenting, percutaneous nephrostomy, or delayed reconstruction [1, 3] . Previous studies have suggested that the timing of recognition is associated with subsequent management and treatment outcomes. A recent meta-analysis of 46 studies reported a lower rate of management failure among ureteral injuries detected intraoperatively than among those detected postoperatively [4].

Nevertheless, iatrogenic ureteral injury is uncommon, and individual institutional series are generally small and heterogeneous. Moreover, the relationship between the timing of diagnosis and the actual management pathway—including urinary diversion, stent placement, definitive reconstruction, additional interventions, and long-term urological outcomes—has not been fully characterized. Retrograde ureteral stenting can successfully manage some injuries that are initially unrecognized, whereas other patients require nephrostomy or subsequent reconstruction, illustrating the heterogeneity of postoperative management [3].

Therefore, the present study aimed to describe the clinical characteristics, management strategies, and long-term urological outcomes of patients with iatrogenic ureteral injury treated at a single institution and to compare observed management patterns and outcomes between injuries diagnosed intraoperatively and those diagnosed postoperatively.

Methods

Study design and patient selection

This retrospective single-center study included patients with iatrogenic ureteral injury identified at our institution between January 1, 2000 and December 31, 2025. Potential cases were identified by searching the electronic medical records for entries corresponding to “ureteral injury” or “ureteral transection.” A total of 35 patients were identified. Eleven patients were excluded because the available clinical information was insufficient for analysis, leaving 24 patients in the final study cohort (Fig. 1).

Patients were classified according to the timing of diagnosis. Intraoperative diagnosis was defined as recognition of ureteral injury during the index surgical procedure in which the injury occurred, whereas postoperative diagnosis was defined as recognition after completion of the index surgery. Fifteen patients were classified into the intraoperative diagnosis group and nine into the postoperative diagnosis group.

Data collection and definitions

Clinical information was retrospectively extracted from medical records, operative reports, and available imaging studies. Collected variables included age, sex, underlying disease, department and type of index surgery, surgical approach, laterality and anatomical site of ureteral injury, injury mechanism and extent, concomitant injuries, urinary extravasation, urinoma, infection at diagnosis, diagnostic method, and time from index surgery to diagnosis.

Injury mechanism was classified as transection, thermal injury, perforation, or unknown according to the available clinical and operative records. Injury extent was classified as complete, partial, or unknown. Information that could not be determined from the available records was classified as unknown rather than inferred from the clinical course.

Preoperative ureteral stenting was recorded separately from stent placement used as treatment for ureteral injury.

Management

Management-related variables included initial management, nephrostomy placement, ureteral stent placement, definitive repair during the index surgery, type of definitive reconstruction, time from the index surgery to definitive repair, and the need for additional intervention.

Ureteral stent placement was recorded when a stent was used as part of the management of the ureteral injury, including placement concomitant with surgical repair. Definitive repair during the index surgery was defined as definitive ureteral reconstruction performed during the surgical procedure in which the ureteral injury occurred. Reconstructive procedures were recorded according to the operative reports. When secondary reconstruction was required, the type and timing of the subsequent procedure were also recorded.

All time intervals were calculated from the date of the index surgery in which the ureteral injury occurred.

Follow-up and clinical outcomes

Long-term outcomes were assessed using the last available clinical information. Recorded outcomes included recurrent ureteral stricture, permanent ureteral stenting, permanent nephrostomy, nephrectomy, functional loss of the affected kidney, and the need for additional intervention.

Final outcome was classified as favorable, unfavorable, or unknown. An unfavorable outcome was defined as permanent urinary drainage, persistent ureteral obstruction or urinary leakage, functional loss of the affected kidney, or nephrectomy at the last evaluable follow-up. Patients in whom the long-term urological outcome could not be adequately assessed, including those who died from progression of the underlying disease before the urinary tract outcome could be determined, were classified as having an unknown final outcome. Death from the underlying disease alone was not considered an unfavorable urological outcome.

Statistical analysis

Continuous variables are presented as medians and interquartile ranges, and categorical variables as numbers and percentages. Management strategies and clinical outcomes were compared between the intraoperative and postoperative diagnosis groups. Fisher's exact test was used for categorical comparisons because of the small sample size. For variables containing unknown values, only patients with evaluable data were included in the denominator for the corresponding analysis.

Given the limited sample size and retrospective study design, between-group comparisons were considered exploratory and were not used to infer causal relationships between diagnostic timing and management or clinical outcomes. All statistical tests were two-sided, and a *p* value < 0.05 was considered statistically significant. Statistical analyses were performed using R software, version 4.5.1 (R Foundation for Statistical Computing, Vienna, Austria).

Use of generative artificial intelligence

ChatGPT (OpenAI) was used to assist with the organization, language refinement, and drafting and revision of portions of the manuscript. It was not used to generate or modify study data or to perform statistical analyses. All content prepared with this assistance was critically reviewed and revised by the authors, who take full responsibility for the accuracy and integrity of the final manuscript.

Results

Patient selection and clinical characteristics

A total of 35 patients with ureteral injury or ureteral transection were identified from the electronic medical records between January 2000 and December 2025. Eleven patients were excluded because of insufficient clinical data, leaving 24 patients for analysis (Fig. 1). Ureteral injury was diagnosed intraoperatively in 15 patients (62.5%) and postoperatively in 9 (37.5%).

The median age of the study population was 57.8 years (interquartile range [IQR], 46.6–68.9), and 19 patients (79.2%) were female. The index surgery was performed by the Department of Gynecology in 12 patients (50.0%), gastrointestinal surgery in 9 (37.5%), urology in 1 (4.2%), and other departments in 2 (8.3%). The underlying disease was malignant in 11 patients (45.8%) and benign in 9 (37.5%). Most index procedures were performed using an open surgical approach (22/24, 91.7%) (Table 1).

Ureteral injuries involved the right side in 10 patients (41.7%), the left side in 11 (45.8%), and both sides in 3 (12.5%). The injury site was the upper ureter in 2 patients (8.3%), middle ureter in 11 (45.8%), and lower ureter in 11 (45.8%). The documented injury mechanisms included transection in 8 patients (33.3%), thermal injury in 4 (16.7%), and perforation in 1 (4.2%); the mechanism could not be determined in 11 patients (45.8%). Complete and partial injuries were documented in 11 (45.8%) and 8 patients (33.3%), respectively, whereas the extent was unknown in 5 (20.8%). Urinary extravasation, urinoma, and

infection at diagnosis were documented in 5 (20.8%), 2 (8.3%), and 7 patients (29.2%), respectively (Table 1).

Management according to diagnostic timing

Management strategies differed according to the timing of diagnosis (Table 2). Definitive repair during the index surgery was performed in 13 of 15 patients (86.7%) diagnosed intraoperatively compared with 2 of 9 patients (22.2%) diagnosed postoperatively ($p = 0.003$).

Ureteral stents were used in 14 patients (93.3%) in the intraoperative diagnosis group and 4 (44.4%) in the postoperative diagnosis group ($p = 0.015$). In contrast, nephrostomy was performed in 1 patient (6.7%) in the intraoperative group and 4 patients (44.4%) in the postoperative group ($p = 0.047$). Additional interventions were required in 2 patients (13.3%) and 2 patients (22.2%), respectively, with no statistically significant difference between the groups ($p = 0.615$).

Follow-up and clinical outcomes

The median follow-up duration was 8.0 months (IQR, 3.6–22.2) in the intraoperative diagnosis group and 8.8 months (IQR, 1.1–41.1) in the postoperative diagnosis group (Table 3).

Recurrent ureteral stricture was observed in 2 of 15 evaluable patients (13.3%) in the intraoperative group and none of 8 evaluable patients in the postoperative group ($p = 0.526$). Permanent ureteral stenting was required in 3 of 15 patients (20.0%) and 2 of 9 patients (22.2%), respectively ($p = 1.000$), while permanent nephrostomy was required in 1 of 15 patients (6.7%) and 2 of 9 patients (22.2%), respectively ($p = 0.533$). No patient underwent nephrectomy.

Functional loss of the affected kidney was documented in 1 of 15 evaluable patients (6.7%) in the intraoperative group and none of 7 evaluable patients in the postoperative group ($p = 1.000$).

Final urological outcome was evaluable in 14 patients in the intraoperative group and 5 patients in the postoperative group. An unfavorable final outcome was observed in 4 of 14 patients (28.6%) and 2 of 5 patients (40.0%), respectively ($p = 1.000$). No statistically significant differences in the evaluated long-term clinical outcomes were observed between the two groups.

Discussion

In this retrospective single-center study of 24 patients with iatrogenic ureteral injury, management patterns differed according to the timing of diagnosis. Patients whose injuries were recognized intraoperatively more frequently underwent definitive repair during the index surgery and ureteral stent placement, whereas nephrostomy was more frequently used in patients diagnosed postoperatively. In contrast, no statistically significant differences were observed in the evaluated long-term urological outcomes. Given the small sample size, retrospective design, and heterogeneity of the injuries, these

findings should be interpreted as descriptive and exploratory rather than evidence of a causal effect of diagnostic timing.

The observed differences in management are clinically plausible. When a ureteral injury is recognized during the index operation, the injury can be assessed directly and reconstruction can potentially be performed without a separate procedure[1, 5]. In our cohort, definitive repair during the index surgery was performed in 86.7% of patients diagnosed intraoperatively compared with 22.2% of those diagnosed postoperatively. Ureteral stents were also more frequently used in the intraoperative group. Importantly, stent placement in this study included stents placed concomitantly with surgical reconstruction and should therefore not be interpreted as stent-only management. These findings indicate that intraoperative recognition and definitive surgical management frequently occurred within the same operative setting in this cohort.

In contrast, nephrostomy was more frequently performed in patients diagnosed postoperatively. Postoperative ureteral injuries may present after the index operation with urinary leakage, obstruction, infection, or other clinical findings requiring urinary diversion before definitive management can be considered[2, 3, 6, 7]. In such situations, nephrostomy can provide temporary urinary drainage while the extent of injury and the patient's clinical condition are assessed[3, 6, 7]. Our findings therefore demonstrate different observed management pathways between intraoperatively and postoperatively recognized injuries. However, the present study cannot determine whether diagnostic timing itself caused these differences. Injury severity, injury mechanism and location, the underlying disease, patient condition, and the circumstances of the index surgery may all have influenced both the timing of recognition and subsequent treatment selection [4, 8].

This distinction is particularly important because detailed injury characteristics were not uniformly available in our cohort. Complete injury was documented in 45.8% of patients and partial injury in 33.3%, whereas the extent could not be determined in 20.8%. Similarly, the injury mechanism was unknown in 45.8% of patients. Urinary extravasation, urinoma, and infection at diagnosis were identified in some patients, but the small number of cases did not permit meaningful adjustment for these potential confounders. Consequently, multivariable analysis to determine whether diagnostic timing was independently associated with management selection or outcome was not appropriate. Future studies with larger cohorts and standardized characterization of injury severity will be necessary to distinguish the effect of diagnostic timing from that of the injury itself [4, 8].

Despite the differences in management, we did not identify statistically significant differences in the evaluated long-term urological outcomes between the two groups. Rates of recurrent stricture, permanent ureteral stenting, permanent nephrostomy, functional loss of the affected kidney, and unfavorable final outcome were not significantly different. This finding should not be interpreted as evidence that the timing of diagnosis has no effect on long-term outcome. Previous studies have reported increased morbidity and additional procedures after delayed recognition, although long-term reconstructive outcomes have not been uniformly worse [6, 9]. The number of evaluable patients was

particularly limited for some endpoints, and patients whose long-term urological status could not be adequately assessed were classified as having an unknown outcome rather than being assigned to either the favorable or unfavorable category. This approach reduced the number of patients available for outcome comparison but avoided classifying deaths from progression of the underlying disease as adverse outcomes attributable to ureteral injury.

The present study also illustrates some of the difficulties inherent in evaluating iatrogenic ureteral injury. The condition is uncommon, and even over a 25-year study period only 24 patients had sufficiently detailed clinical information for analysis at our institution. The long observation period enabled the accumulation of these uncommon cases but introduced substantial heterogeneity. Similar methodological heterogeneity has been reported across published series of iatrogenic ureteral injury, particularly with respect to outcome definitions, follow-up protocols, and treatment timing [8]. Surgical approaches, diagnostic imaging, perioperative management, reconstructive techniques, and clinical documentation changed during the study period. Furthermore, most index procedures in this cohort were open surgeries, which may limit the applicability of our findings to contemporary practice, in which minimally invasive and robotic procedures are increasingly used. These characteristics emphasize the need for multicenter studies using standardized definitions and prospectively specified variables.

This study has several limitations. First, its retrospective, single-center design and small sample size limit statistical power and generalizability. Second, the 25-year study period introduced temporal heterogeneity in surgical and diagnostic practice. Third, detailed information regarding injury mechanism and extent was unavailable in a substantial proportion of patients, particularly in older records. Fourth, treatment selection was not standardized and was determined according to the clinical circumstances of each case; therefore, confounding by injury severity, patient condition, and surgical context cannot be excluded. Fifth, follow-up duration varied considerably, and long-term urological outcomes could not be evaluated in all patients. Finally, the small number of events precluded multivariable adjustment for potential confounders.

Nevertheless, this study provides a detailed description of the clinical characteristics, management pathways, and follow-up outcomes of iatrogenic ureteral injuries according to the timing of recognition. Rather than demonstrating an independent effect of diagnostic timing, our findings show that intraoperatively and postoperatively recognized injuries were managed differently in this cohort. Larger multicenter studies incorporating standardized injury classification, treatment criteria, and long-term functional outcomes are needed to clarify how diagnostic timing, injury severity, and management strategy interact to influence the clinical course of iatrogenic ureteral injury [4, 8].

Conclusions

In this retrospective single-center study, intraoperatively diagnosed iatrogenic ureteral injuries were more frequently managed with definitive repair during the index surgery, whereas postoperative diagnosis was associated with more frequent use of nephrostomy. No statistically significant differences were

observed in the evaluated long-term urological outcomes. These findings should be interpreted cautiously because of the small sample size, retrospective design, and heterogeneity of the study population. Larger multicenter studies using standardized definitions of injury characteristics, management, and long-term outcomes are warranted.

Abbreviations

IQR: Interquartile range

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of the University of Yamanashi (approval No. 2741). Because of the retrospective nature of the study, an opt-out approach was used for participation.

Clinical trial number

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The datasets analyzed during the current study are not publicly available because they contain clinical information that could potentially compromise patient privacy. Requests for access to the data may be directed to the corresponding author and will be considered in accordance with institutional and ethical requirements.

Competing interests

The authors declare that they have no competing interests.

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No funding was received for this study.

Authors' contributions

TMo conceived and designed the study and acquired the data. KS and TT analyzed and interpreted the data. TMo drafted the manuscript. NS, HS, SK, and TMi critically revised the manuscript for important intellectual content. RF, RS, and TMo performed the statistical analysis. All authors reviewed the manuscript and approved the final version.

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Tables

Table 1. Patient and injury characteristics of the study cohort

Characteristic	Total cohort (n = 24)
Age, years, median (IQR)	57.8 (46.6-68.9)
Sex	
Female	19 (79.2)
Male	5 (20.8)
Department of index surgery	
Gynecology	12 (50.0)
Gastrointestinal surgery	9 (37.5)
Urology	1 (4.2)
Other	2 (8.3)
Disease type	
Malignant	11 (45.8)
Benign	9 (37.5)
Other	4 (16.7)
Surgical approach	
Open	22 (91.7)
Laparoscopic	1 (4.2)
Endoscopic	1 (4.2)
Laterality	
Right	10 (41.7)
Left	11 (45.8)
Bilateral	3 (12.5)
Injury site	
Upper ureter	2 (8.3)
Middle ureter	11 (45.8)
Lower ureter	11 (45.8)
Injury mechanism	
Transection	8 (33.3)
Thermal injury	4 (16.7)

Perforation	1 (4.2)
Unknown	11 (45.8)
Injury extent	
Complete	11 (45.8)
Partial	8 (33.3)
Unknown	5 (20.8)
Concomitant injury	1 (4.2)
Urinary extravasation	
Present	5 (20.8)
Absent	18 (75.0)
Unknown	1 (4.2)
Urinoma	
Present	2 (8.3)
Absent	20 (83.3)
Unknown	2 (8.3)
Infection at diagnosis	
Present	7 (29.2)
Absent	16 (66.7)
Unknown	1 (4.2)
Diagnostic timing	
Intraoperative	15 (62.5)
Postoperative	9 (37.5)

Data are presented as n (%) unless otherwise indicated. Age is presented as median (interquartile range). Unknown indicates that the relevant information could not be determined from the available medical records.

Table 2. Management strategies according to the timing of diagnosis

Management strategy	Intraoperative diagnosis (n = 15)	Postoperative diagnosis (n = 9)	p value
Nephrostomy	1 (6.7)	4 (44.4)	0.047
Ureteral stent	14 (93.3)	4 (44.4)	0.015
Definitive repair during index surgery	13 (86.7)	2 (22.2)	0.003
Additional intervention	2 (13.3)	2 (22.2)	0.615

Data are presented as n (%). Comparisons between the intraoperative and postoperative diagnosis groups were performed using Fisher's exact test. A two-sided p value < 0.05 was considered statistically significant. Ureteral stent indicates stent placement as part of the management of ureteral injury, including placement concomitant with surgical repair. Definitive repair during index surgery was defined as definitive ureteral repair performed during the surgical procedure in which the ureteral injury occurred.

Table 3. Follow-up and clinical outcomes according to the timing of diagnosis

Outcome	Intraoperative diagnosis	Postoperative diagnosis	p value
Follow-up, months, median (IQR)	8.0 (3.6-22.2)	8.8 (1.1-41.1)	-
Recurrent ureteral stricture	2/15 (13.3)	0/8 (0)	0.526
Permanent ureteral stent	3/15 (20.0)	2/9 (22.2)	1.000
Permanent nephrostomy	1/15 (6.7)	2/9 (22.2)	0.533
Nephrectomy	0/15 (0)	0/9 (0)	-
Functional loss of affected kidney	1/15 (6.7)	0/7 (0)	1.000
Unfavorable final outcome	4/14 (28.6)	2/5 (40.0)	1.000

Data are presented as n/N (%) unless otherwise indicated. Follow-up duration is presented as median (interquartile range). N represents the number of patients with evaluable data for each outcome. Patients with unknown outcome data were excluded from the denominator for the corresponding analysis. Comparisons between the intraoperative and postoperative diagnosis groups were performed using Fisher's exact test. A two-sided p value < 0.05 was considered statistically significant. Final outcome was classified as unfavorable when permanent urinary drainage, persistent ureteral obstruction or urinary leakage, functional loss of the affected kidney, or nephrectomy was present at the last evaluable follow-up.

Figures

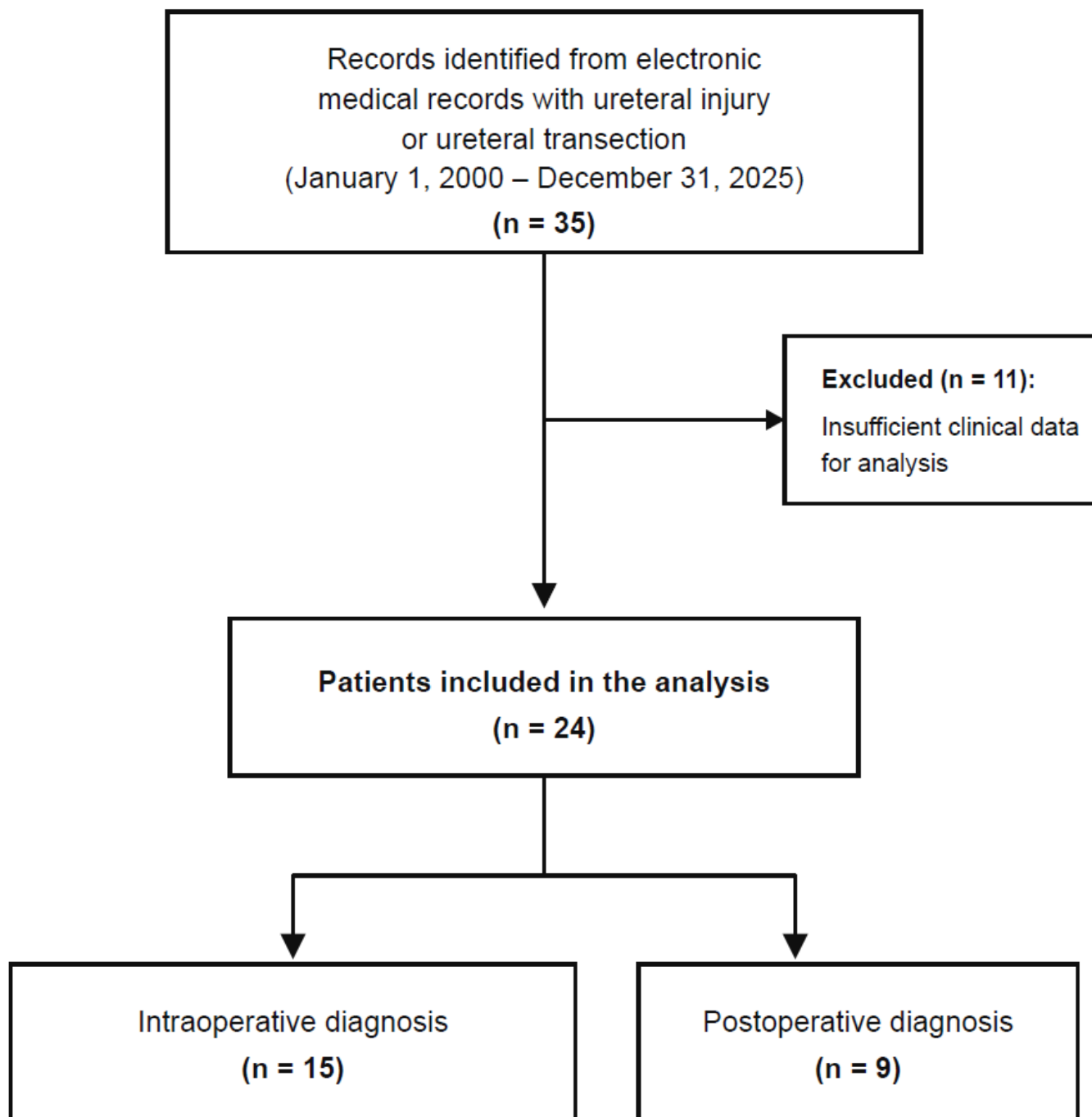


Figure 1

Patient selection flow diagram.

A total of 35 patients with ureteral injury or ureteral transection were identified from electronic medical records between January 1, 2000 and December 31, 2025. Eleven patients were excluded because of insufficient clinical data, leaving 24 patients for analysis. Of these, 15 were diagnosed intraoperatively and 9 postoperatively.