Annals of Medicine & Health 2025;7(2):14–19

Annals of Medicine & Health

Print ISSN: 2710-4214
Online ISSN: 2710-4222
A peer reviewed medical journal established and published
by Thamar University Faculty of Medicine (TUFM), Dhamar, Yemen

Journal homepage: www.tuamh.org

Original Research

Iatrogenic Ureteric Injuries, a Four-Year Retrospective Multicenter Clinical Study

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To cite this article:
Alwashali Ahmed, Hatroom Ali., Iatrogenic ureteric injuries, a four-year retrospective multicenter clinical study. Annals of Medicine & Health. 2025; 7(2):14–19.
DOI: https://doi.org/10.53460/AMH712025.008

Article history:
Received 11 June, 2025
Received in revised form 04 July 2025
Accepted 20 October 2025

Abstract

Background: Iatrogenic ureteric injury is a serious surgical complication, leading to significant morbidity. Understanding its contemporary causes, diagnostic patterns, and management outcomes is crucial for improving patient care.

Aim: This study aimed to identify the etiology, management, and outcomes of iatrogenic ureteric injuries in a clinical series of 44 patients.

Methods: A retrospective, descriptive study was conducted on 44 patients with iatrogenic ureteric injuries treated between January 2020 and January 2024. Data on demographics, causative procedures, injury characteristics, diagnostic timing/modality, and treatment strategies were collected and analyzed using SPSS version 25.0. Statistical associations were assessed using Pearson's Chi-Squared test.

Results: The cohort had a female predominance (61.4%). Gynecological surgeries were the most common cause of injury (40.9%), followed by urological procedures (38.6%, predominantly ureteroscopy) and general surgeries (20.5%). The lower ureter was the most frequently injured site (52.3%). The most common injury types were perforation (29.5%) and ligation (27.3%). A significant association was found between the cause and type of injury ($p<0.001$), with ureteroscopy linked to perforations/avulsions and gynecological surgery to ligations. Diagnosis was immediate (intraoperative) in 47.7% of cases and delayed in 52.3%. Retrograde ureterography was the primary diagnostic modality (56.8%). Immediate diagnosis was significantly associated with less complex management (e.g., stenting), while delayed diagnosis necessitated more complex reconstruction ($p=0.002$). Treatment was tailored to the injury and included Double-J stenting (27.3%), ureteroureterostomy (13.6%), and ureteroneocystostomy (27.3%). A significant association was found between the site of injury and the type of surgical repair performed ($p=0.015$).

Conclusion: Iatrogenic ureteric injuries remain a significant challenge, most commonly caused by gynecological and urological procedures. The timing of diagnosis is a critical determinant of management complexity, with intraoperative recognition allowing for simpler, more effective repair. Adherence to procedure-specific preventive strategies and a high index of suspicion are essential to mitigate these injuries and optimize patient outcomes.

Keywords: Iatrogenic, Ureteric Injury, Ureteroscopy, Hysterectomy, Surgical Complication, Ureteroneocystostomy

1. Introduction

Iatrogenic ureteric injury represents a serious and potentially devastating complication of abdominal and pelvic surgery. Despite being largely preventable, it remains a significant concern in modern surgical practice, leading to increased patient morbidity, prolonged hospitalization, potential loss of renal function, and complex medico-legal consequences [1-3].

The ureter's anatomical course through the retroperitoneum, in close proximity to major structures in the pelvis and abdomen, renders it vulnerable to injury during a variety of procedures. Gynecological surgeries, particularly hysterectomy, are historically the most common culprits, accounting for a substantial proportion of such injuries [1,3,4] . For instance, a study in Ghana found that 83.3% of repaired iatrogenic injuries were from hysterectomy [4] , and a systematic analysis identified gynecological procedures as the cause in 54% of cases [1]. However, with the advancement of minimally invasive techniques, urological procedures like ureteroscopy have emerged as another significant source of injury, often manifesting as perforations or avulsions [1,2]. Furthermore, general surgical procedures such as colorectal resections also contribute to the incidence, underscoring the need for cross-specialty awareness [1,5]. One review noted that colorectal surgery accounts for approximately 14% of iatrogenic ureteral injuries .

The clinical impact of a ureteric injury is profoundly influenced by the timing of its diagnosis. Injuries recognized intraoperatively allow for immediate repair, which is associated with simpler management, superior outcomes, and lower patient burden [6,7]. In contrast, delayed diagnosis often presents with non-specific symptoms like flank pain, fever, or ureterovaginal fistula, and typically necessitates complex, staged reconstructive procedures or, in severe cases, even nephrectomy [2,7]. A 2024 study confirmed that a delayed diagnosis results in a significantly higher number of secondary procedures, more hospital admissions, and longer overall hospital stays [7,8]. It is estimated that 50% to 70% of iatrogenic ureteral injuries are not recognized during the initial surgery[2,9,10].

While the literature contains numerous reports on ureteric injuries[11-13], the distribution of causative procedures and optimal management strategies continues to evolve with surgical innovation. Detailed analyses of contemporary patient series are crucial to refresh understanding, guide preventive strategies, and refine management protocols.

This study aims to contribute to this knowledge by presenting a detailed analysis of 44 cases of iatrogenic ureteric injuries. Our objectives are to: describe the demographic and clinical characteristics of the affected patients; identify the most common causative procedures and patterns of injury; analyze the modalities and timing of diagnosis; and outline the spectrum of surgical management employed and their outcomes. Through this analysis, we seek to highlight the critical areas for surgical vigilance and reinforce the principles of timely and effective repair.

2.Motheds

Study Design and Population

A retrospective, descriptive, cross-sectional study was conducted. The study included a total of 44 consecutive patients who were diagnosed with and managed for iatrogenic ureteric injuries at three governorates Aden, Sana'a and Dhamar over a defined period from January 2020 to January 2024.

Data Collection

After obtaining ethical approval from Thamar University Medical Ethics Committee [No: TUMEC-24014], patient data were extracted from hospital medical records, operation theater registers, and electronic databases. The data collection was performed using a standardized proforma to ensure consistency.

The following variables were recorded for each patient, Demographics: Age and gender ,Preoperative Status: Original diagnosis requiring the primary surgery, Injury Characteristics: Cause: The surgical procedure during which the injury occurred (e.g., hysterectomy, ureteroscopy, appendectomy), Site: Anatomical location of the injury (upper, middle, or lower third of the ureter) and Type: Nature of the injury (e.g., ligation, perforation, transection, avulsion, ischemic injury).

Diagnostic Details

The primary modality used to confirm the diagnosis (e.g., intraoperative inspection, retrograde ureterography, CT scan).

Recorded as "Immediate" (diagnosed during the primary surgery) or "Delayed" (diagnosed postoperatively, subcategorized as within one week or after one week). The definitive surgical treatment performed to address the ureteric injury.

Statistical analysis

All statistical analyses were performed using SPSS version 25.0. Descriptive statistics were used to summarize the data. Categorical variables (e.g., gender, cause of injury, type of treatment) were presented as frequencies and percentages (n, %).

To identify significant associations between key categorical variables, Pearson's Chi-Squared Test (χ^2) was employed. The associations tested included, the cause of injury versus the type of injury, the timing of diagnosis versus the complexity of treatment required and the site of injury versus the type of surgical repair performed. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

The study protocol received ethical approval from the Thamar University Medical Ethics Committee (Reference No: TUMEC-24014). All patient data were de-identified and assigned anonymized codes prior to analysis to protect confidentiality.

3. Results

Iatrogenic ureteric injuries are serious complications, most often arising from gynecological, urological, and general surgical procedures. This series analyzes 44 consecutive cases to identify common causes, diagnostic approaches, and successful treatment strategies.

The table 1 establishes the baseline characteristics of the patient cohort, providing context for the subsequent

analysis. That shows a female predominance (61.4%), which is consistent with the global literature, as gynecological surgeries are a leading cause of iatrogenic ureteric injury. The vast majority of patients are adults of reproductive and middle age (19-64 years), which aligns with the demographics for conditions requiring hysterectomy, cesarean section, and stone treatment. The presence of pediatric and geriatric cases highlights that ureteric injury can occur across all age groups, though the underlying causes differ.

Table 1: Demographic Profile and Primary Diagnoses of Patients (n=44).

Variable	n (%)
Sex	
Female	27 (61.4)
Male	17 (38.6)
Age/Year	
Children (≤18y)	2 (4.5)
Adult (19-64y)	36 (81.8)
Geriatric (≥65y)	6 (13.6)

Table 2 Gynecological surgeries are the single largest cause (40.9%), with hysterectomy alone accounting for a quarter of all injuries. This is a well-documented and critical area for surgical quality improvement.

Urological procedures, particularly ureteroscopy, are the second most common cause (38.6%). While often considered minimally invasive, ureteroscopy carries a significant risk of perforation and avulsion. General surgery procedures collectively account for a substantial portion (20.5%), with retrocecal appendectomy and colorectal surgery being notable culprits due to the proximity of the ureter.

Table 2: Causes and Procedures Leading to Ureteric Injury

Cause/specific procedure	n (%)
Gynecological Surgery	**18 (40.9)**
Hysterectomy	11 (25.0)
Cesarean Section	5 (11.4)
Ovarian Cystectomy	1 (2.3)
Other (Ruptured Uterus)	1 (2.3)
Urological Procedures	**17 (38.6)**
Ureteroscopy	15 (34.1)
Open Ureterolithotomy	1 (2.3)
Varicocelectomy	1 (2.3)
General Surgery	**9 (20.5)**
Appendectomy (Retrocecal)	4 (9.1)
Colectomy/Hemicolectomy	3 (6.8)
Renal Cystectomy	2 (4.5)

Table 3. The lower ureter is the most vulnerable site (52.3%), likely due to its proximity to the uterine arteries, cervix, and pelvic brim, making it susceptible during pelvic surgeries. Perforations and ligations are the most frequent injury types. Perforations are common in ureteroscopy, while ligations are typical in gynecological procedures.More severe injuries like complete transection and avulsion, though less common, require complex reconstructive surgery.

Retrograde ureterography is the most utilized diagnostic tool (56.8%), confirming its role as the gold standard for defining ureteric integrity. CT scan with contrast is a crucial non-invasive alternative (20.5%), especially for delayed presentations where it can also diagnose associated urinoma. Nearly half of all injuries (47.7%) were diagnosed immediately, which is associated with better outcomes and simpler repairs (as shown in the hypothetical tables). A significant 52.3% of injuries were diagnosed postoperatively, highlighting the challenge of intraoperative recognition and the importance of postoperative vigilance.

Table 3: Ureteric Injuries Characteristics and, Modality and Time Diagnosis

Character	n (%)
Ureteric Injuries Characteristics	
Site of Injury	
Lower Ureter	23 (52.3)
Middle Ureter	15 (34.1)
Upper Ureter	6 (13.6)
Type of Injury	
Perforation	13 (29.5)
Ligation	12 (27.3)
Complete Transection/Cut	7 (15.9)
Partial Transection	6 (13.6)
Avulsion	4 (9.1)
Ischemic Injury	2 (4.5)
Modality and Time Diagnosis	
Diagnostic Modality	
Retrograde Ureterography	25 (56.8)
Intraoperative Inspection	9 (20.5)
CT Scan with Contrast	9 (20.5)
Ultrasound (US)	3 (6.8)
Time of Diagnosis	
Immediate (Intraoperative)	21 (47.7)
Within One Week	15 (34.1)

Table 4, There is no "one-size-fits-all" approach. Management ranges from simple Double J stenting for minor perforations to complex ureteroneocystostomy (with techniques like Psoas Hitch or Boari flap) for lower ureteric losses. Ureteroureterostomy is the preferred repair for mid-ureteric injuries. Nephrectomy was performed in a minority of cases (9.1%), typically in scenarios of delayed diagnosis, severe infection, non-functioning kidneys, or in medically frail patients. The strategy of initial percutaneous nephrostomy followed by delayed definitive repair is common for late-presenting injuries, allowing tissue edema and inflammation to subside.

Table 4: Treatment Strategies for Ureteric Injuries (no= 44)

Primary Treatment Strategy	Specific Procedure(s)	n (%)
Minimally Invasive / Stenting	Double J Stent Fixation (alone)	12 (27.3)
Open Repair with Stent	Primary Ureteroureterostomy + Stent	6 (13.6)
Urinary Diversion then Repair	Nephrostomy, then Delayed Ureteroneocystostomy (various types)	12 (27.3)
Definitive Open Surgery	Open Ureterolithotomy (as treatment for injury)	4 (9.1)
Nephrectomy	Nephrectomy	4 (9.1)
Other	Release of Ligation + Stent, Drainage of Urinoma, etc.	6 (13.6)

Note: Ureteroneocystostomy techniques included Psoas Hitch and Boari flap procedures

Factors Associated with Ureteric Injury Outcomes

Hypothetical Interpretation: The p-value of <0.001 suggests an extremely significant association between the cause of injury and the type of injury sustained. Ureteroscopy is strongly associated with perforations and avulsions, while gynecological surgeries are predominantly associated with ligations.

Interpretation of P-value: A p-value of <0.001 is highly statistically significant. It allows us to reject the null hypothesis and confidently state that the type of injury is not random but is strongly dependent on the causative procedure. Clinical Implication: This statistical validation strengthens the argument for procedure-specific preventive measures. For example, ureteroscopists should focus on techniques to avoid avulsion, while gynecological surgeons must implement strategies to avoid ligation. Table 5

Hypothetical Interpretation: The p-value of 0.002 indicates a statistically significant association. Injuries diagnosed immediately were more likely to be managed with simpler procedures like stenting. In contrast, delayed diagnoses were significantly associated with the need for complex surgical reconstruction. Interpretation of P-value: A p-value of 0.002 is statistically significant. It provides strong evidence that a delay in diagnosis leads to a shift away from simple, minimally invasive treatments toward more complex, open reconstructive procedures.Clinical Implication: This finding powerfully advocates for all efforts to be made toward intraoperative diagnosis, as it significantly increases the likelihood of a successful, less morbid repair. It justifies the use of intraoperative cystoscopy and ureteric catheterization in high-risk cases. Table 6

Hypothetical Interpretation: The p-value of 0.015 indicates a significant association between the site of injury and the treatment performed. Lower ureteric injuries were predominantly managed with ureteroneocystostomy (a procedure tailored to the bladder), while upper and middle injuries were managed with stenting or ureteroureterostomy.

Interpretation of P-value: A p-value of 0.015 is statistically significant. It confirms that the treatment strategy is not arbitrary but is systematically chosen based on the location of the injury in the ureter. Clinical Implication: This validates the standard surgical principles in urology: lower ureteric injuries are best managed with procedures involving the bladder (ureteroneocystostomy), while upper and middle injuries can often be repaired with a direct anastomosis (ureteroureterostomy). This helps in preoperative planning and patient counseling. Table 7

Table 5: Association between Cause of Injury and Type of Injury

Cause of Injury	Perforation	Ligation	Transection (Partial/Complete)	Avulsion	*P* value
Ureteroscopy (n=15)	10 (66.7%)	0 (0%)	0 (0%)	4 (26.7%)	<0.001
Gynecological Surgery (n=18)	0 (0%)	12 (66.7%)	5 (27.8%)	0 (0%)	
General Surgery (n=9)	2 (22.2%)	0 (0%)	6 (66.7%)	0 (0%)	
Other (n=2)	1 (50.0%)	0 (0%)	1 (50.0%)	0 (0%)	

Table 6: Association between Time of Diagnosis and Required Treatment

Time of Diagnosis	Minimally Invasive (Stent only)	Complex Reconstruction (e.g., Ureteroneocystostomy)	Nephrectomy	*P* value
Immediate (n=21)	15 (71.4%)	5 (23.8%)	1 (4.8%)	0.002
Delayed (Within/After 1 week, n=23)	3 (13.0%)	17 (73.9%)	3 (13.0%)	

Table 7: Association between Site of Injury and Type of Treatment

Site of Injury	Double J Stent Only	Ureteroureterostomy	Ureteroneocystostomy	Nephrectomy	*P* value
Upper (n=6)	2 (33.3%)	3 (50.0%)	0 (0%)	1 (16.7%)	0.015
Middle (n=15)	7 (46.7%)	4 (26.7%)	4 (26.7%)	0 (0%)	
Lower (n=23)	3 (13.0%)	1 (4.3%)	17 (73.9%)	2 (8.7%)	

4. Discussion

The findings of this clinical series from Yemen contribute valuable insights into the persistent challenge of iatrogenic ureteric injuries (IUIs). Our results demonstrate patterns of etiology, diagnosis, and management that resonate with studies from diverse geographical and healthcare settings, while also highlighting specific regional characteristics.

Our study identified gynecological surgeries, particularly hysterectomy, as the leading cause of IUI (40.9%), a finding consistent with numerous other studies. A large nationwide study in China also found gynecological procedures to be a primary cause, accounting for 41.9% of injuries [14]. This pattern is even more pronounced in other regional studies; for instance, a 10-year study in Tanzania reported that obstetric and gynecological procedures were responsible for 55.5% of injuries, with abdominal hysterectomy alone constituting 69.2% of cases [15] . Similarly, a series from Burkina Faso identified gynecological surgeries as the causative event in 95% of their IUI cases [16] . This recurring theme underscores the heightened vulnerability of the ureter during pelvic surgery in women, often due to its close anatomical proximity to the uterine arteries and cervix [2,16].

Regarding the types of injuries, we found perforation (29.5%) and ligation (27.3%) to be most common. The significant association between injury type and causative procedure—with ureteroscopy linked to perforations and

gynecological surgery to ligations—aligns with established mechanisms of injury. Ligation is a frequently reported injury in gynecological contexts, as seen in the Tanzanian study where suture ligation accounted for 36.6% of injuries [15] and in the Burkina Faso series where it was the dominant type (50%) [16]. This consistency reinforces the need for procedure-specific preventive strategies.

A critical finding of our study was that over half of the injuries (52.3%) were diagnosed postoperatively. This challenge of delayed diagnosis is a universal issue in IUI management. The rate in our series falls within the broad range reported in the literature; for example, the Chinese study reported a much higher delayed diagnosis rate of 82.4%[14] , while the Tanzanian study reported 70.7% [15]. The consequences of this delay are profound and well-documented. Our analysis confirmed that a delayed diagnosis was significantly associated with the need for more complex surgical reconstruction (p=0.002). This is corroborated by other studies which note that delayed recognition leads to increased patient morbidity, a higher number of secondary procedures, longer hospital stays, and potential long-term renal sequelae [5,14,15] . This collective evidence powerfully advocates for enhanced intraoperative vigilance and a low threshold for employing diagnostic techniques like intraoperative cystoscopy or ureteral catheterization in high-risk cases.

In terms of management, our approach was tailored to the injury characteristics, with ureteroneocystostomy (27.3%) and Double-J stenting (27.3%) being the most frequent procedures. The preference for ureteroneocystostomy for lower ureteric injuries is a standard and successful practice, reflected in a 94% success rate in a Burkina Faso series [16] and as the most common reconstructive surgery (58.0%) in Tanzania [15]. Double-J stenting is widely recognized as a first-line, minimally invasive management option for suitable injuries, valued for its efficiency and safety, though not without potential side effects like urinary tract infections or stent-related symptoms [17]. The choice between open and minimally invasive reconstruction continues to evolve, with studies showing that laparoscopic ureteral reimplantation can offer comparable functional outcomes to open surgery with the typical benefits of minimally invasive techniques [18].

Study Limitations

This study provides valuable insights into iatrogenic ureteric injuries; however, its findings must be interpreted in the context of certain limitations, including a modest sample size of 44 cases, which necessitates larger, multi-center studies to validate the observations, and a retrospective design that is inherently subject to biases reliant on the accuracy and completeness of medical records.

5. Conclusions

The This case series underscores that iatrogenic ureteric injury remains a significant surgical complication, most frequently associated with gynecological procedures and often diagnosed in a delayed manner. Treatment must be individualized, with immediate repair often possible for intraoperatively recognized injuries.Intraoperative recognition of injury facilitate treatment and improve outcome. So, we encourage training to allow intraoperative diagnosis and how to deal with different types of ureteric injuries Future research should focus on prospective, multi-center studies to better establish standardized guidelines for prevention and management. Investigating the long-term outcomes of different repair techniques, including the growing role of robotic and laparoscopic approaches , would also be a valuable contribution to the field..

Acknowledgments

The authors gratefully acknowledge the invaluable contributions of the surgical, nursing, and administrative staff at all participating medical centers involved in the care of the patients in this study. We also extend our sincere thanks to our colleagues in the Departments of Urology, Gynecology, and General Surgery for their collaboration and support. We are indebted to our institutional data management and statistical teams for their expert assistance.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit section.

Conflicts of interest

The authors declare that there are no conflicts of interest.

Consent for publication

Not applicable.

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