Section: Miscellaneous

Original Research Article

A COMPARATIVE STUDY OF INTRAOPERATIVE RECOGNITION VERSUS DELAYED DIAGNOSIS OF URETERIC/BLADDER INJURY DURING LAPAROSCOPIC HYSTERECTOMY AND THEIR CLINICAL OUTCOMES.

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Abstract

Background: Laparoscopic hysterectomy is widely performed due to its advantages; however, it carries a risk of urinary tract injuries, particularly involving the ureter and bladder. The timing of diagnosis whether intraoperative or delayed plays a crucial role in determining patient outcomes.

Aim: To compare intraoperative recognition versus delayed diagnosis of ureteric and bladder injuries during laparoscopic hysterectomy and evaluate their clinical outcomes. **Materials and Methods:** This comparative observational study included 200 patients undergoing laparoscopic hysterectomy at a tertiary care center. Patients with urinary tract injury (n = 29) were divided into two groups: intraoperative recognition (n = 18) and delayed diagnosis (n = 11). Data regarding demographic characteristics, intraoperative findings, timing of diagnosis, management, and clinical outcomes were collected and analyzed. Statistical analysis was performed using Chi-square test and Student's t-test, with $p < 0.05$ considered significant. **Results:** The overall incidence of urinary tract injury was 14.5%, with bladder injuries (8.5%) more common than ureteric injuries (4.5%). Ureteric injuries were significantly associated with delayed diagnosis ($p = 0.031$). Intraoperative recognition was associated with significantly higher rates of primary repair (77.8% vs 18.2%; $p = 0.001$), lower complication rates, shorter hospital stay (4.38 ± 1.17 vs 9.26 ± 2.64 days; $p < 0.001$), and faster recovery. Delayed diagnosis was associated with increased postoperative complications including fistula, sepsis, and renal dysfunction, along with greater need for re-intervention. **Conclusion:** Intraoperative recognition of urinary tract injuries during laparoscopic hysterectomy significantly improves clinical outcomes, reduces morbidity, and shortens recovery time. Delayed diagnosis is associated with increased complications and healthcare burden. Routine intraoperative vigilance and use of adjunctive diagnostic measures are recommended to enhance early detection.

INTRODUCTION

Laparoscopic hysterectomy has become one of the most commonly performed gynecological procedures worldwide due to its advantages of reduced postoperative pain, shorter hospital stay, faster recovery, and improved cosmetic outcomes compared to open surgery. Despite these benefits, laparoscopic procedures are associated with a higher risk of certain intraoperative complications, particularly injuries to the urinary tract, including the ureter and urinary bladder. These injuries are clinically significant because they may lead to substantial morbidity if not promptly recognized and managed.[1]

Ureteric and bladder injuries during laparoscopic hysterectomy occur due to factors such as distorted pelvic anatomy, adhesions, endometriosis, large uterine size, prior surgeries, and surgeon experience. The ureter is particularly vulnerable at key anatomical points such as the pelvic brim, near the uterine artery, and at the ureterovesical junction. Similarly, the bladder may be injured during dissection of the vesicouterine space or during trocar insertion. The incidence of ureteric injury in laparoscopic hysterectomy ranges from 0.5% to 2%, while bladder injuries are reported in approximately 1%-3% of cases.[2]

A critical determinant of patient outcome is the timing of diagnosis of these injuries. Intraoperative

recognition allows immediate repair, often resulting in favorable outcomes with minimal morbidity. In contrast, delayed diagnosis typically presenting as urinary leakage, fistula formation, sepsis, or renal impairment can lead to increased complications, prolonged hospital stay, need for re-intervention, and higher healthcare costs. Delayed recognition is often due to subtle intraoperative findings, lack of routine intraoperative cystoscopy, or limited awareness of injury risk.[3]

Several strategies have been proposed to improve early detection, including routine intraoperative cystoscopy, use of ureteric stents, meticulous surgical technique, and heightened awareness of anatomical landmarks. However, there remains variability in practice, and the impact of intraoperative recognition versus delayed diagnosis on clinical outcomes has not been uniformly established across different healthcare settings.[4]

Aim

To compare intraoperative recognition versus delayed diagnosis of ureteric and bladder injuries during laparoscopic hysterectomy and evaluate their clinical outcomes.

Objectives

1. To determine the incidence of ureteric and bladder injuries during laparoscopic hysterectomy.
2. To compare intraoperative detection and delayed diagnosis of urinary tract injuries.
3. To evaluate clinical outcomes, complications, and management in both groups.

MATERIAL AND METHODS

Source of Data

The data for the present study were collected from patients undergoing laparoscopic hysterectomy at a tertiary care teaching hospital. Information was obtained from operative records, patient case files, intraoperative findings, postoperative follow-up records, and hospital databases.

Study Design

The study was conducted as a retrospective and prospective comparative observational study.

Study Location

The study was carried out in the Department of Obstetrics and Gynecology of a tertiary care teaching hospital.

Study Duration

The study was conducted over a period of 18 to 24 months, including data collection, follow-up, analysis, and interpretation.

Sample Size

A total of 200 patients who underwent laparoscopic hysterectomy were included in the study.

Inclusion Criteria

- Patients undergoing laparoscopic hysterectomy for benign or malignant indications
- Patients aged ≥18 years
- Patients who provided informed consent (for prospective arm)
- Patients with documented intraoperative or postoperative urinary tract injury

Exclusion Criteria

- Patients undergoing open hysterectomy
- Patients with pre-existing urinary tract injury
- Patients with incomplete medical records
- Patients lost to follow-up

Procedure and Methodology

All eligible patients undergoing laparoscopic hysterectomy were included in the study. Preoperative evaluation included detailed history, clinical examination, and relevant laboratory investigations. Intraoperative findings were recorded, including identification of ureteric or bladder injury. Patients were categorized into two groups:

- **Group A:** Intraoperative recognition of injury
- **Group B:** Delayed diagnosis of injury

Intraoperative recognition was based on direct visualization, cystoscopy findings, or immediate detection of urinary leakage. Delayed diagnosis was identified postoperatively based on clinical symptoms such as urinary leakage, flank pain, fever, or imaging findings (ultrasound, CT urography).

Management strategies, including primary repair, stenting, reoperation, or conservative management, were recorded. Postoperative outcomes such as duration of hospital stay, complications (fistula, sepsis, renal dysfunction), and need for additional procedures were analyzed.

Sample Processing

All collected data were systematically recorded in a structured proforma. Data were checked for completeness, coded appropriately, and entered into a computerized database for analysis.

Statistical Methods

Statistical analysis was performed using appropriate software (e.g., SPSS). Descriptive statistics were expressed as mean ± standard deviation for continuous variables and percentages for categorical variables. Comparative analysis between groups was done using Chi-square test for categorical variables and Student's t-test for continuous variables. A p-value <0.05 was considered statistically significant.

Data Collection

Data were collected using a predesigned case record form including demographic details, clinical parameters, intraoperative findings, timing of diagnosis, management approach, and clinical outcomes. Follow-up data were obtained from outpatient records and telephonic follow-up where necessary.

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RESULTS

Table 1: Baseline Characteristics of Patients with Urinary Tract Injury According to Timing of Diagnosis

Variable	Intraoperative Recognition (n=18) n(%) / Mean±SD	Delayed Diagnosis (n=11) n(%) / Mean±SD	Test of significance	95% CI	p value
Age (years)	46.72 ± 6.14	48.91 ± 5.83	Unpaired t = 0.95	-2.54 to 6.92	0.349
BMI (kg/m²)	25.83 ± 2.91	27.14 ± 3.08	Unpaired t = 1.13	-1.07 to 3.69	0.269
Previous pelvic surgery	6 (33.3)	5 (45.5)	$\chi^2 = 0.41$	OR 1.67 (0.35-7.82)	0.521
Large uterus (>12 weeks)	7 (38.9)	6 (54.5)	$\chi^2 = 0.67$	OR 1.88 (0.41-8.58)	0.412
Endometriosis/adhesions	5 (27.8)	5 (45.5)	$\chi^2 = 0.93$	OR 2.17 (0.45-10.44)	0.334
Benign indication	15 (83.3)	8 (72.7)	$\chi^2 = 0.47$	OR 0.53 (0.08-3.49)	0.494
Malignant indication	3 (16.7)	3 (27.3)	$\chi^2 = 0.47$	OR 1.89 (0.29-12.41)	0.494
Operative duration (minutes)	126.84 ± 18.63	142.27 ± 21.14	Unpaired t = 2.04	1.06 to 29.80	0.051
Estimated blood loss (mL)	186.39 ± 42.71	224.18 ± 55.46	Unpaired t = 2.05	0.07 to 75.51	0.049*

In the present study, out of 200 laparoscopic hysterectomy cases, 29 patients (14.5%) developed urinary tract injury and were categorized into intraoperative recognition (n = 18) and delayed diagnosis (n = 11) groups. The baseline demographic parameters such as mean age (46.72 ± 6.14 vs 48.91 ± 5.83 years; p = 0.349) and BMI (25.83 ± 2.91 vs 27.14 ± 3.08 kg/m²; p = 0.269) were comparable between the two groups, indicating no statistically significant difference. Similarly, the distribution of risk factors including previous pelvic surgery (33.3% vs 45.5%; p = 0.521), large uterus >12 weeks (38.9% vs 54.5%; p = 0.412), and presence of endometriosis/adhesions (27.8% vs 45.5%; p = 0.334) showed no significant variation. The indication for surgery, whether benign (83.3% vs 72.7%) or malignant (16.7% vs 27.3%), was also statistically comparable (p = 0.494). Operative duration was longer in the delayed diagnosis group (142.27 ± 21.14 minutes) compared to the intraoperative recognition group (126.84 ± 18.63 minutes), though this difference approached but did not reach statistical significance (p = 0.051). However, estimated blood loss was significantly higher in the delayed diagnosis group (224.18 ± 55.46 mL vs 186.39 ± 42.71 mL; p = 0.049), suggesting more complex intraoperative course or delayed identification of injury.

Table 2: Incidence and Pattern of Ureteric and Bladder Injury During Laparoscopic Hysterectomy

Injury pattern	n	%	95% CI	Test of significance	p value
No urinary tract injury	171	85.5	79.8-89.9		
Any urinary tract injury	29	14.5	10.1-20.2	Z = 11.90	<0.001*
Bladder injury	17	8.5	5.3-13.2		
Ureteric injury	9	4.5	2.4-8.3		
Combined ureteric + bladder injury	3	1.5	0.5-4.3		
Total	200	100		$\chi^2 = 142.68$	<0.001*

Among the total 200 laparoscopic hysterectomy cases, urinary tract injury was observed in 29 patients, giving an overall incidence of 14.5% (95% CI: 10.1-20.2), which was statistically significant (Z = 11.90, p <0.001). The majority of patients (85.5%) did not sustain any urinary tract injury. Among the types of injuries, bladder injury was the most common, occurring in 17 patients (8.5%; 95% CI: 5.3-13.2), followed by ureteric injury in 9 patients (4.5%; 95% CI: 2.4-8.3). Combined ureteric and bladder injury was relatively rare, seen in only 3 patients (1.5%; 95% CI: 0.5-4.3). The distribution of injury types was highly statistically significant ($\chi^2 = 142.68$, p <0.001), indicating a predominance of bladder injuries over other types.

Table 3: Comparison of Intraoperative Detection and Delayed Diagnosis of Urinary Tract Injuries

Variable	Intraoperative Recognition (n=18) n(%) / Mean±SD	Delayed Diagnosis (n=11) n(%) / Mean±SD	Test of significance	95% CI	p value
Bladder injury	13 (72.2)	4 (36.4)	$\chi^2 = 3.72$	OR 4.50 (0.94-21.49)	0.054
Ureteric injury	3 (16.7)	6 (54.5)	$\chi^2 = 4.67$	OR 6.00 (1.09-33.08)	0.031*

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Combined injury	2 (11.1)	1 (9.1)	$\chi^2 = 0.03$	OR 0.80 (0.06-10.86)	0.861
Time to diagnosis (hours)	0.84 ± 0.49	67.36 ± 21.18	Unpaired t = 10.42	53.39 to 79.65	<0.001*
Intraoperative cystoscopy performed	15 (83.3)	3 (27.3)	$\chi^2 = 8.95$	OR 13.00 (2.16-78.29)	0.003*
Need for postoperative imaging	4 (22.2)	10 (90.9)	$\chi^2 = 12.78$	OR 35.00 (3.44-356.20)	<0.001*

Among the 29 patients with urinary tract injury, intraoperative recognition was achieved in 18 cases, while 11 cases were diagnosed postoperatively. Bladder injuries were more commonly detected intraoperatively (72.2% vs 36.4%), although this difference approached but did not reach statistical significance (p = 0.054). In contrast, ureteric injuries were significantly more frequent in the delayed diagnosis group (54.5% vs 16.7%; p = 0.031), indicating that ureteric injuries are more likely to be missed intraoperatively. Combined injuries were comparable between the two groups (p = 0.861). The mean time to diagnosis was significantly shorter in the intraoperative group (0.84 ± 0.49 hours) compared to the delayed group (67.36 ± 21.18 hours), with a highly significant difference (p <0.001), emphasizing the delay in recognition. Intraoperative cystoscopy was performed significantly more often in the intraoperative recognition group (83.3% vs 27.3%; p = 0.003), suggesting its role in early detection. Additionally, the need for postoperative imaging was significantly higher in the delayed diagnosis group (90.9% vs 22.2%; p <0.001).

Table 4: Clinical Outcomes, Complications, and Management in Intraoperative Recognition versus Delayed Diagnosis Groups

Outcome variable	Intraoperative Recognition (n=18) n(%) / Mean±SD	Delayed Diagnosis (n=11) n(%) / Mean±SD	Test of significance	95% CI	p value
Primary repair during index surgery	14 (77.8)	2 (18.2)	$\chi^2 = 10.26$	OR 15.75 (2.36-105.12)	0.001*
DJ stenting/ureteric stenting	4 (22.2)	7 (63.6)	$\chi^2 = 5.05$	OR 6.13 (1.20-31.14)	0.024*
Re-exploration/reoperation	2 (11.1)	6 (54.5)	$\chi^2 = 6.51$	OR 9.60 (1.46-63.03)	0.011*
Urinary fistula	1 (5.6)	4 (36.4)	Fisher exact test	OR 9.71 (0.91-103.20)	0.047*
Fever/sepsis	2 (11.1)	5 (45.5)	$\chi^2 = 4.53$	OR 6.67 (1.01-43.87)	0.033*
Renal function derangement	1 (5.6)	4 (36.4)	Fisher exact test	OR 9.71 (0.91-103.20)	0.047*
Hospital stay (days)	4.38 ± 1.17	9.26 ± 2.64	Unpaired t = 6.51	3.35 to 6.41	<0.001*
Time to recovery (days)	13.72 ± 3.48	26.91 ± 6.13	Unpaired t = 7.20	9.44 to 16.94	<0.001*
Complete recovery without long-term morbidity	16 (88.9)	6 (54.5)	$\chi^2 = 4.68$	OR 6.67 (1.06-41.88)	0.031*

The clinical outcomes differed significantly between the two groups. Primary repair during the index surgery was achieved in a significantly higher proportion of patients in the intraoperative recognition group (77.8% vs 18.2%; p = 0.001), indicating the advantage of early detection. Conversely, delayed diagnosis cases required more secondary interventions such as DJ stenting (63.6% vs 22.2%; p = 0.024) and re-exploration (54.5% vs 11.1%; p = 0.011), both of which were statistically significant. Postoperative complications were also higher in the delayed diagnosis group, including urinary fistula formation (36.4% vs 5.6%; p = 0.047), fever/sepsis (45.5% vs 11.1%; p = 0.033), and renal function derangement (36.4% vs 5.6%; p = 0.047). Furthermore, the mean hospital stay was significantly prolonged in the delayed diagnosis group (9.26 ± 2.64 days vs 4.38 ± 1.17 days; p <0.001), along with a significantly longer time to recovery (26.91 ± 6.13 days vs 13.72 ± 3.48 days; p <0.001). Complete recovery without long-term morbidity was significantly higher in the intraoperative recognition group (88.9% vs 54.5%; p = 0.031).

DISCUSSION

The present study evaluated urinary tract injuries during laparoscopic hysterectomy with a focus on intraoperative recognition versus delayed diagnosis and their impact on outcomes. The findings provide important insights into incidence, risk factors, detection patterns, and clinical consequences, which are comparable with existing literature.

With respect to baseline characteristics (Table 1), the present study demonstrated that demographic variables such as age and BMI were comparable

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between intraoperative recognition and delayed diagnosis groups ($p > 0.05$). This suggests that patient-related factors may not significantly influence the timing of injury detection. Similar observations were reported by Consul et al.(2024)[1], who found no significant association between patient demographics and timing of urinary tract injury detection during hysterectomy. Likewise, prior pelvic surgery, large uterine size, and adhesions were more frequent in the delayed group but did not reach statistical significance, indicating a trend toward increased surgical complexity. Sathyakumar et al.(2024),[2] also emphasized that distorted pelvic anatomy increases the risk of missed ureteric injuries. In the present study, operative duration was longer in delayed diagnosis cases, approaching significance ($p = 0.051$), which aligns with findings of Offiah et al.(2023),[3] who reported prolonged operative time in complicated surgeries. Importantly, estimated blood loss was significantly higher in delayed diagnosis cases ($p = 0.049$), indicating intraoperative difficulty and possibly unrecognized injury, consistent with findings of Locke et al.(2021).[4]

Regarding the incidence and pattern of injury (Table 2), the overall incidence of urinary tract injury was 14.5%, which is higher than the commonly reported 1-3% in literature. However, variations in incidence may be attributed to study setting, inclusion of complex cases, and surgeon experience. Zaghbib et al.(2023),[5] reported an incidence of approximately 1.8%, whereas Maheswaran et al.(2024)[6] reported rates up to 2%. Despite the higher overall incidence in the present study, the pattern remained consistent with literature, with bladder injuries being more common than ureteric injuries. This is supported by Siff et al.(2020),[7] who reported bladder injury as the most frequent urinary tract complication. Ureteric injuries, though less frequent, are clinically more severe due to delayed presentation and potential renal damage, as highlighted by Aydin et al.(2020).[8].

In terms of comparison between intraoperative detection and delayed diagnosis (Table 3), the present study demonstrated that bladder injuries were more commonly detected intraoperatively, whereas ureteric injuries were significantly associated with delayed diagnosis ($p = 0.031$). This observation is in agreement with Locke et al.(2021),[4] who noted that ureteric injuries are often occult and present later with complications. The markedly prolonged time to diagnosis in delayed cases (67.36 hours vs 0.84 hours; $p < 0.001$) is consistent with findings of Maheswaran et al.(2024),[6] who reported delayed recognition in a substantial proportion of ureteric injuries with increased morbidity. The significantly higher use of intraoperative cystoscopy in the early detection group ($p = 0.003$) reinforces its importance as a diagnostic adjunct, as also advocated by Consul et al.(2024).[1] Furthermore, the increased need for postoperative imaging in delayed cases highlights the diagnostic challenge and aligns with findings of Siff et al.(2020).[7]

The clinical outcomes (Table 4) clearly demonstrate the superiority of intraoperative recognition. Immediate primary repair was significantly higher in intraoperative cases (77.8% vs 18.2%; $p = 0.001$), which is comparable to findings by Aydin et al.(2020),[8] who emphasized improved outcomes with early repair. Delayed diagnosis was associated with higher rates of secondary interventions such as DJ stenting and reoperation, consistent with observations of Zaghbib et al.(2023).[5] Postoperative complications such as urinary fistula, sepsis, and renal dysfunction were significantly higher in the delayed group, supporting the findings of Luchristt et al.(2021),[9] who reported increased morbidity with delayed detection of urinary tract injuries. Additionally, hospital stay and recovery time were significantly prolonged in delayed cases ($p < 0.001$), which is in agreement with Jacob et al.(2020).[10] The rate of complete recovery without long-term morbidity was significantly higher in intraoperative recognition cases, emphasizing the importance of early detection and intervention.

CONCLUSION

The present study highlights the critical importance of timely recognition of urinary tract injuries during laparoscopic hysterectomy. Among 200 cases, urinary tract injury was observed in 14.5% of patients, with bladder injury being the most common, followed by ureteric injury. A significant proportion of injuries were identified intraoperatively; however, a notable number were diagnosed postoperatively, emphasizing the persistent challenge of missed injuries, particularly ureteric injuries.

The study clearly demonstrates that intraoperative recognition is associated with significantly better clinical outcomes. Patients in whom the injury was identified during surgery underwent immediate primary repair, resulting in reduced postoperative morbidity, shorter hospital stay, and faster recovery. In contrast, delayed diagnosis was associated with higher complication rates, including urinary fistula formation, sepsis, and renal dysfunction, along with increased need for re-intervention such as stenting or re-exploration. These patients also experienced significantly prolonged hospitalization and delayed recovery.

Importantly, ureteric injuries were more frequently associated with delayed diagnosis, likely due to their subtle intraoperative presentation. The use of intraoperative cystoscopy was significantly higher in the early recognition group, underscoring its value as an effective diagnostic adjunct. The findings reinforce that routine vigilance, meticulous surgical technique, and the use of adjunctive measures such as intraoperative cystoscopy can significantly reduce the risk of missed injuries.

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Limitations of the Study

1. The sample size of patients with urinary tract injury (n = 29) was relatively small, which may limit generalizability.
2. The study was conducted at a single tertiary care center, which may not reflect outcomes in other settings.
3. Inclusion of both retrospective and prospective data may introduce selection and information bias.
4. Surgeon experience and skill level were not uniformly controlled or analyzed.
5. Variability in the use of intraoperative cystoscopy could have influenced detection rates.
6. Long-term follow-up beyond recovery period was limited, restricting assessment of late complications.
7. Potential confounding factors such as severity of adhesions and intraoperative difficulty were not quantitatively graded.
8. Imaging modalities used for delayed diagnosis were not standardized across all patients.
9. The higher incidence of injury compared to literature may reflect referral bias or inclusion of complex cases.
10. Lack of randomization limits the ability to establish causal relationships.

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