

INTRAOPERATIVE RECOGNITION AND SURGICAL MANAGEMENT OF URINARY BLADDER INJURIES DURING OBSTETRIC AND GYNAECOLOGICAL PROCEDURES: IMPACT ON PATIENT OUTCOMES

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ABSTRACT

Background: Urinary bladder injury is an important complication of obstetric and gynecological surgeries, with a reported incidence of 0.1–0.5% in routine procedures, rising up to 3–4% in high-risk settings such as placenta accreta spectrum (PAS). Early intraoperative recognition and prompt repair are critical to prevent significant morbidity. This study provides one of the few prospective evaluations of intraoperative bladder injury management in a high-volume Indian tertiary centre. **Objective:** To prospectively evaluate the intraoperative characteristics, management strategies, and outcomes of bladder injuries encountered during obstetric and gynecological surgeries at a tertiary care centre. **Materials and Methods:** This prospective observational study included 35 patients with intraoperative bladder injuries managed between December 2023 and September 2025. Data regarding patient characteristics, type of surgery, injury location and size, intraoperative findings, repair techniques, and postoperative outcomes were analysed using descriptive statistics. **Results:** The mean age was 31.9 years. The majority of injuries occurred during obstetric hysterectomy for PAS (52%), followed by LSCS in previously operated patients (32%). The bladder dome was the most common site of injury (86%), with a mean defect size of 4.1 × 3.6 cm. Preoperative ureteric stenting was performed in 23% of high-risk cases. All injuries were identified intraoperatively and repaired primarily using a standardized two-layer technique. No ureteric injuries or postoperative urinary leaks were observed. All patients demonstrated intact repair on cystography at 21 days, with 100% successful catheter removal and preserved continence. No cases of fistula or voiding dysfunction were noted at 6-month follow-up. **Conclusion:** In this prospective series of 35 patients, intraoperative recognition and immediate standardized repair of bladder injuries resulted in excellent outcomes with no major postoperative complications. A multidisciplinary approach and structured surgical protocol are key to optimizing outcomes, particularly in high-risk PAS cases.

INTRODUCTION

Urinary bladder injury constitutes one of the most common forms of lower urinary tract trauma encountered during pelvic surgery [1]. The reported incidence varies widely, ranging from approximately 0.1% to 0.9% in routine hysterectomy and increasing to 3–4% in caesarean hysterectomy, particularly in the setting of placenta accreta spectrum (PAS) [2]. The rising global rate of caesarean deliveries has contributed to a parallel increase in postoperative adhesions and abnormal placentation, thereby amplifying the risk of iatrogenic bladder injury [2]. Distortion of normal pelvic anatomy—secondary to dense vesicouterine adhesions, prior surgical

interventions, or invasive placentation—poses significant intraoperative challenges. These factors obscure dissection planes and increase susceptibility to inadvertent cystotomy [3]. Failure to recognize such injuries intraoperatively is associated with considerable morbidity, including urinary fistula formation, persistent urinary leakage, infection, and the need for reoperation [1,3]. Existing literature predominantly comprises retrospective analyses, with limited prospective data addressing real-time intraoperative decision-making, the role of early urological involvement, and the application of standardized repair techniques, particularly in emergency obstetric scenarios. In this context, the present prospective study aims to systematically

evaluate intraoperative bladder injuries encountered during obstetric and gynaecologic procedures over a two-year period. The study focuses on mechanisms of injury, intraoperative challenges, surgical management strategies, and short-term clinical outcomes, with an emphasis on optimizing multidisciplinary care and improving patient safety.

MATERIALS AND METHODS

This prospective observational study included 35 consecutive cases of intraoperative urinary bladder injury referred to the Department of Urology at B. J. Medical College and Civil Hospital, Ahmedabad, a high-volume tertiary care referral centre in western India, over a study period from December 2023 to September 2025. All cases were intraoperatively identified during obstetric and gynecological procedures and subsequently referred by the Department of Obstetrics and Gynecology for specialized urological evaluation and management.

Data were collected prospectively using a standardized and pre-validated proforma to ensure uniformity and completeness. Patient-related variables included demographic characteristics (age, parity), prior surgical history (particularly previous caesarean sections or pelvic surgeries), and relevant clinical background. Procedure-related details such as the type of surgery, indication (including emergency versus elective), and underlying pathology were systematically documented.

Bladder injuries were comprehensively characterized based on intraoperative assessment, including anatomical location, size, depth, and extent of involvement. Associated operative findings—such as the presence of dense adhesions, intraoperative haemorrhage, inflammatory changes, and degree of surgical field distortion—were recorded to assess procedural complexity.

Details of urological intervention were meticulously documented, including timing of repair, surgical technique employed, suture material used, number of closure layers, and bladder drainage strategy. Postoperative management protocols, including duration of urethral catheterization, use of adjunctive drainage, and need for imaging (e.g., cystography), were recorded.

Patients were followed systematically to assess both short-term and long-term outcomes, including urinary leak, fistula formation, voiding function, and need for reintervention. The collected data were analysed to evaluate the effectiveness of intraoperative repair strategies and to identify clinical and intraoperative factors influencing surgical outcomes.

Surgical Protocol

Following identification of the bladder defect, the wound edges were meticulously debrided and refreshed until viable, well-vascularized tissue margins were achieved.

The defect was subsequently repaired in a two-layer closure using 2-0 polyglactin (Vicryl) sutures, ensuring a watertight seal.

The inner mucosal layer was approximated using a continuous suturing technique to achieve precise epithelial alignment.

The outer seromuscular layer was reinforced with interrupted sutures to provide additional strength and reduce tension across the repair site.

A 22 French Foley catheter was inserted intraoperatively to facilitate continuous urinary drainage and minimize intravesical pressure on the repair.

The catheter was maintained indwelling for a duration of 21 days to allow adequate healing of the bladder wall.

On postoperative day 21, all patients underwent a stress cystographic evaluation to assess the integrity of the repair and to exclude any evidence of urinary leakage prior to catheter removal.

In cases where a concomitant ureteric injury was identified, appropriate management was undertaken with placement of a ureteric stent during the same operative session to ensure ureteral patency and facilitate healing.

Follow-Up Protocol

Patients were followed up at 6 weeks and 6 months postoperatively with:

- Clinical evaluation (voiding symptoms, leakage, infection)
- Ultrasonography of the urinary tract to detect residual collection, hydronephrosis, or incomplete healing.

Patients with persistent symptoms or abnormal imaging underwent micturating cystourethrogram (MCU) or cystoscopy as indicated.



Figure 1: Intraoperative identification of bladder injury during obstetric surgery showing defect at bladder dome



Figure 2: Primary repair of bladder injury using a two-layer closure technique with 2-0 polyglactin sutures



Figure 3: Postoperative stress cystogram performed on day 21 demonstrating no contrast extravasation, confirming intact repair



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RESULTS

A total of 35 female patients with intraoperative bladder injuries during obstetric or gynecological surgeries were included.

The mean age was 31.9 years (range 24–46 years).

All patients were hemodynamically stable at presentation, with mean hemoglobin 9.7 g/dL, mean WBC 10,960/mm³, and mean serum creatinine 0.85 mg/dL.

Preoperative and Intraoperative Finding

Preoperative evaluation with ultrasonography and/or magnetic resonance imaging (MRI) facilitated the diagnosis of placenta previa or placenta percreta in 13 patients (37%), allowing for planned, coordinated multidisciplinary management involving obstetrics and urology teams.

In patients with antenatal suspicion of placenta percreta, preoperative ureteric stenting was performed in 8 cases (23%) to enhance intraoperative ureteral visualization and minimize the risk of iatrogenic injury. Notably, no ureteric injuries were documented in this cohort.

All bladder injuries were identified intraoperatively and managed immediately by the urology team, enabling timely and definitive surgical repair.

The operative field was frequently characterized by significant technical challenges, including dense adhesions, increased vascularity, and distorted pelvic anatomy, particularly in patients with a history of prior cesarean sections.

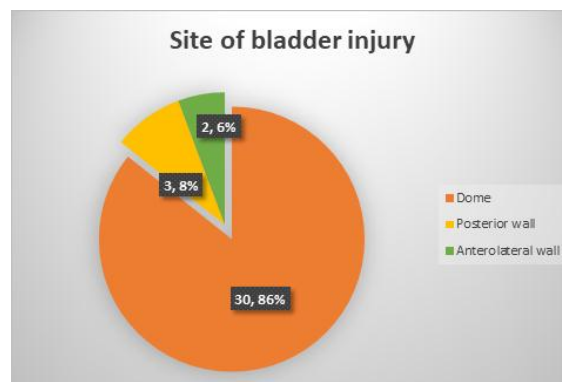
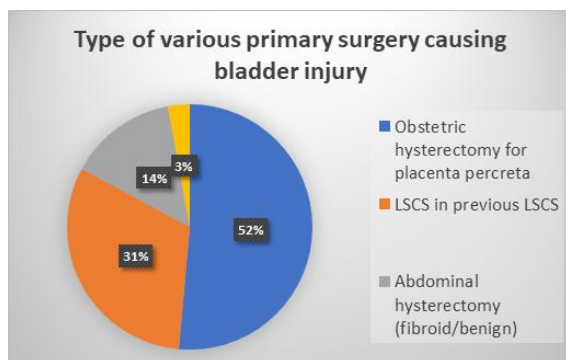
Dense vesicouterine adhesions were observed in 8 patients (23%) undergoing lower segment cesarean section (LSCS) following multiple prior cesarean deliveries. These adhesions complicated bladder dissection and mobilization, thereby increasing the susceptibility to inadvertent cystotomy.

Among patients diagnosed with placenta accreta spectrum disorders ($n = 18$, 63%), placental tissue was noted to be either invading or firmly adherent to the posterior bladder wall in 10 cases (35%). This resulted in substantial intraoperative haemorrhage, with an average estimated blood loss of approximately 1 litre, and obliteration of the normal dissection plane between the bladder and uterus.

Hemodynamic instability necessitating inotropic support (noradrenaline and/or dopamine) was encountered in 8 patients (32%). This included six patients undergoing obstetric hysterectomy for placenta percreta and two patients with extensive adhesions secondary to previous LSCS.

Despite these intraoperative complexities, all bladder injuries were accurately delineated and successfully repaired primarily in two layers using 2-0 polyglactin (Vicryl) sutures following meticulous hemostasis.

Post-repair, all patients achieved hemodynamic stability and were subsequently transferred to the intensive care unit for close postoperative monitoring and supportive care.



Site and Size of Bladder Injury

The average size of bladder injury was 4.1×3.6 cm (range 1×1 cm to 10×5 cm).

Table 1

Parameter	Finding	Number of Patients (%)
Preoperative imaging	Identified placenta previa or placenta percreta	13 (37%)
Preoperative ureteric stenting	Performed to aid ureteral identification in suspected placenta percreta	8 (23%)
Ureteric injuries	Observed	0 (0%)
Bladder injuries recognized intraoperatively	Promptly repaired by urology team	100% of bladder injury cases
Dense vesicouterine adhesions	Encountered in patients with multiple prior LSCS	8 (28%)
Placenta accreta spectrum disorders	Cases	18 (63%)
Placenta invading/densely adherent to posterior bladder wall	Among placenta accreta spectrum cases	10 (35% overall)
Average intraoperative blood loss	In cases of placenta invading bladder	~1 litre
Inotropic support required	Due to intraoperative hypotension	8 (28%)
		– 6 after hysterectomy for placenta percreta
		– 2 with dense adhesions from prior LSCS

Postoperative Outcome and Complications

Following completion of bladder repair, a 28 Fr abdominal drain (ADK) was routinely placed in the pelvis in all patients to facilitate early detection of urinary leakage or postoperative fluid collection.

Continuous bladder decompression was maintained using a 22 Fr Foley catheter, which was kept indwelling for a period of 21 days postoperatively to ensure optimal healing of the repair site.

In the majority of patients ($n = 31$, 88%), drain output remained minimal and serous in nature, permitting safe removal of the drain on postoperative day (POD) 2.

A subset of patients ($n = 4$, 12%) demonstrated increased drain output exceeding 100 mL/day of serosanguinous fluid on POD 3. Biochemical analysis of the drain fluid revealed creatinine levels comparable to serum values, thereby excluding urinary leakage. In these cases, the drain was retained for an additional 1–2 days and subsequently removed without further complications.

No patient exhibited evidence of persistent urinary drainage, urinoma formation, or postoperative urinary leak.

All patients underwent stress cystographic evaluation on postoperative day 21, which demonstrated intact

bladder repair with no evidence of contrast extravasation.

Following confirmation of repair integrity, Foley catheters were removed, and all patients achieved spontaneous voiding with satisfactory urinary stream and preserved continence. The mean duration of catheterization was 21 days (range: 20–22 days).

The mean duration of hospital stay was 8.4 ± 2.1 days. A total of 8 patients (32%) required admission to the intensive care unit for postoperative monitoring, primarily due to intraoperative hemodynamic instability and significant blood loss. No postoperative complications such as urinary tract infection, surgical site infection, or vesicovaginal fistula were observed in this cohort.

Follow-up assessments at 6 weeks and 6 months revealed no complaints of lower urinary tract symptoms, voiding dysfunction, or recurrent urinary tract infections.

Ultrasonographic evaluation during follow-up demonstrated normal bladder wall morphology, with no evidence of residual urine, pelvic collection, or structural abnormality.

There were no instances of mortality recorded during the study period.

Table 2

Parameter	Finding	Number of Patients (%) / Details
Pelvic drain (28 Fr ADK)	Placed in all patients to monitor early leakage/collection	100%
Foley catheter (22 Fr)	Maintained postoperatively for 21 days	Mean duration 21 days (range 20–22)
Drain output minimal and serous	Allowed removal on POD 2	31 (88%)
Drain output >100 mL/day, serosanguinous	No urinary leak; drains removed after 1–2 extra days	4 (12%)
Stress cystography (POD 21)	No dye extravasation	100%
Spontaneous voiding with continence	After catheter removal	100%
Average hospital stay	Duration	8.4 ± 2.1 days

DISCUSSION

Bladder injury continues to represent one of the most frequently encountered urological complications during obstetric and gynecological procedures, particularly in the context of escalating cesarean section rates and the increasing prevalence of placenta accreta spectrum (PAS) disorders.^[4,5]

The growing trend of repeat cesarean deliveries has been strongly associated with the development of dense vesicouterine adhesions and abnormal placental invasion, both of which substantially heighten the risk of inadvertent cystotomy.^[6,7]

In the present prospective cohort of 35 patients, a significant proportion of bladder injuries occurred during obstetric hysterectomy performed for placenta percreta (52%) and during lower segment cesarean section (32%) in women with prior uterine scars. These findings reinforce the well-established association between repeated uterine surgery and increased susceptibility to lower urinary tract injury.^[8]

The anatomical distribution of bladder injuries in this series demonstrated a clear predominance at the bladder dome (86%), consistent with its anatomical proximity to the lower uterine segment during late pregnancy and operative delivery.^[9] In contrast, posterior bladder wall involvement was relatively uncommon (8%) and was exclusively observed in cases of placenta percreta, reflecting the invasive nature of trophoblastic tissue extending beyond the uterine serosa into adjacent pelvic structures. These observations are concordant with previously published literature indicating that the majority of obstetric bladder injuries are associated with prior cesarean delivery and abnormal placentation, often in the setting of distorted surgical planes and compromised tissue integrity.^[8,10]

Preoperative imaging, including ultrasonography and magnetic resonance imaging, played a pivotal role in the early identification of PAS in this cohort, with detection achieved in over half of the patients (52%).^[11,12] This facilitated preoperative planning and the implementation of a structured multidisciplinary approach involving obstetricians, urologists, and anesthesiologists. Advanced imaging not only enables accurate delineation of placental invasion but also assists in anticipating intraoperative challenges such as massive hemorrhage, altered anatomy, and the potential need for adjunctive

urological interventions. In selected high-risk cases, prophylactic ureteric stenting was performed to enhance intraoperative ureteral identification and minimize the risk of iatrogenic injury. This strategy is in alignment with contemporary recommendations advocating multidisciplinary coordination and preoperative preparedness in patients with suspected PAS.^[13,14]

The intraoperative milieu in such patients is frequently complex and technically demanding. In this series, operative challenges included marked hypervascularity, obliteration of normal tissue planes, and dense adhesions secondary to previous surgeries. Placental invasion into or adherence to the posterior bladder wall was observed in 40% of patients with PAS, while 32% exhibited significant vesicouterine adhesions during repeat cesarean section. These factors contributed to substantial intraoperative blood loss, averaging approximately 1 liter, and necessitated inotropic support in nearly one-third of patients due to hemodynamic instability. Such findings underscore the significant physiological and technical burden associated with these procedures and are consistent with existing evidence highlighting the increased risk of urological injury in the setting of extensive adhesions and aberrant vascularity.^[15,16]

A critical determinant of favourable outcomes in this study was the prompt intraoperative recognition and immediate repair of bladder injuries, which was achieved in all cases with the involvement of the urology team. Early identification allows for precise delineation of the defect and facilitates definitive repair under optimal conditions, thereby minimizing the risk of postoperative complications such as urinary fistula or persistent leakage. Existing literature consistently demonstrates that injuries repaired at the time of occurrence are associated with significantly lower morbidity compared to those identified in the postoperative period.^[17]

All bladder injuries in this cohort were managed using a standardized surgical technique involving two-layer closure with 2-0 polyglactin sutures, ensuring a watertight repair. This was followed by prolonged bladder decompression with an indwelling Foley catheter for 21 days and placement of a pelvic drain for early detection of potential leakage. The absence of urinary extravasation, surgical site infection, or vesicovaginal fistula in this series highlights the effectiveness of meticulous surgical

technique combined with appropriate postoperative management. These findings are consistent with established urological guidelines, which advocate absorbable suture repair in two layers along with continuous bladder drainage for an adequate duration to facilitate healing.^[18,19]

Postoperative outcomes in this study were favourable, with a mean hospital stay of 8.4 days, comparable to other tertiary care experiences. The use of biochemical analysis of drain fluid prior to removal further enhanced the ability to detect subclinical urinary leaks, while routine cystographic evaluation at three weeks confirmed complete healing in all patients.

Long-term follow-up at 6 weeks and 6 months demonstrated excellent functional outcomes, with no reported cases of urinary tract infection, voiding dysfunction, or vesicovaginal fistula. Ultrasonographic assessments revealed normal bladder morphology without residual urine or pelvic collections. These findings are consistent with previously reported high success rates of primary bladder repair when performed intraoperatively, with minimal long-term morbidity.^[20]

Overall, the results of this study underscore that early recognition, meticulous surgical repair, and standardized postoperative care are critical determinants of successful outcomes in bladder injury management. Equally important is the integration of a multidisciplinary approach, particularly in high-risk obstetric cases such as PAS, where collaboration between obstetricians, urologists, and anesthesiologists is essential. The consistent involvement of the urology team not only optimizes intraoperative decision-making but also significantly reduces the likelihood of delayed complications, thereby improving both immediate and long-term patient outcomes.

CONCLUSION

Urinary bladder injury during obstetric and gynecologic surgery, though uncommon, represents a significant and largely preventable cause of perioperative morbidity. Patients with prior cesarean deliveries and placenta accreta spectrum are at substantially increased risk due to dense adhesions, distorted pelvic anatomy, and associated haemorrhagic challenges. In such high-risk settings, proactive multidisciplinary planning—including preoperative imaging, availability of urological expertise, and readiness for massive transfusion—is essential to reduce both the incidence of injury and the likelihood of missed diagnosis. Postoperative management, incorporating continuous bladder drainage, close monitoring of pelvic drains, and

confirmatory cystography prior to catheter removal, further ensures repair integrity. Overall, standardized institutional protocols and selective urologist involvement in complex cases are critical to improving surgical safety and patient outcomes.

Our findings further emphasize the critical role of early urological involvement in preventing morbidity associated with bladder injuries.

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