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Original Research Article

Bladder injury at cesarean delivery: a 12-year tertiary center study

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ABSTRACT

Background: Aim was to evaluate the clinical characteristics, timing of recognition, management strategies, and outcomes of bladder injuries occurring during cesarean delivery in a tertiary referral center.
Methods: This retrospective study included all patients diagnosed with bladder injury during cesarean delivery between January 2014 and December 2025. Patients were categorized according to the timing of recognition as intraoperative or postoperative. Demographic, obstetric, and clinical characteristics, as well as management approaches and outcomes, were compared between groups.
Results: Among 16,465 cesarean deliveries, 73 bladder injuries were identified, corresponding to an incidence of 0.44%. The mean maternal age was 32.2±4.1 years. Placenta previa and placenta accreta spectrum (PAS) were present in 58.9% and 56.2% of patients, respectively. Bladder injury was recognized intraoperatively in 61 patients (83.6%) and postoperatively in 12 patients. Intraoperatively recognized injuries were more frequently associated with PAS (62.3% vs. 25.0%, p=0.02), placenta previa (65.6% vs. 25.0%, p=0.01), and ≥2 previous cesarean deliveries (65.6% vs. 33.3%, p=0.04). Gross hematuria was more common among postoperatively recognized injuries. Patients diagnosed postoperatively had longer catheterization duration, longer hospital stay, higher reoperation rates (25.0% vs. 3.3%, p=0.03), and more frequent readmission (50.0% vs. 11.5%, p=0.006).
Conclusions: Most bladder injuries during cesarean delivery are recognized intraoperatively, particularly in patients with PAS and placenta previa. Delayed postoperative recognition is associated with worse postoperative outcomes, highlighting the importance of meticulous intraoperative assessment and postoperative surveillance in high-risk obstetric surgery.

Keywords: Bladder injury, Cesarean delivery, Placenta accreta spectrum, Intraoperative recognition, Postoperative diagnosis

INTRODUCTION

Cesarean delivery is one of the most commonly performed surgical procedures worldwide, with rates continuing to increase in many countries.[1] Although generally considered a safe operation, cesarean delivery is associated with a variety of intraoperative and postoperative complications, including injury to adjacent pelvic organs. Among urological complications, bladder injury represents the most frequently encountered lower urinary tract injury and remains an important source of maternal morbidity.[2,3]

The reported incidence of bladder injury during cesarean delivery ranges from approximately 0.08% to 0.44%, depending on patient characteristics and institutional case mix.[4,5] Several risk factors have been associated with an increased risk of bladder injury, including previous cesarean delivery, dense pelvic adhesions, emergency surgery, placenta previa, and PAS disorders.[6,7] In

particular, abnormal placentation may result in distortion of normal pelvic anatomy and obliteration of surgical planes, substantially increasing the complexity of surgical dissection and the risk of lower urinary tract injury.[8,9]

The clinical presentation of bladder injury is highly variable. While some injuries are recognized immediately during surgery through direct visualization of the defect or urinary leakage into the operative field, others may remain undetected until the postoperative period and present with nonspecific findings such as gross hematuria, suprapubic pain, urinary leakage, or voiding dysfunction.[10,11] Early intraoperative recognition generally allows immediate repair and is associated with favorable outcomes, whereas delayed diagnosis may result in prolonged catheterization, additional interventions, readmission, and increased healthcare utilization.[12-14]

Previous studies have primarily focused on the incidence and risk factors of bladder injury during cesarean delivery. However, limited data are available regarding the timing of recognition and its relationship with clinical characteristics, management strategies, and postoperative outcomes. Understanding factors associated with intraoperative and postoperative diagnosis may help improve perioperative surveillance and optimize patient management, particularly in high-risk obstetric populations.

Therefore, the aim of this study was to evaluate the clinical characteristics, timing of recognition, management approaches, and outcomes of bladder injuries occurring during cesarean delivery in a tertiary referral center.

METHODS

Study design and population

This retrospective observational study was conducted at the Department of Obstetrics and Gynecology, Bursa Yüksek İhtisas Training and Research Hospital, Bursa, Türkiye, a tertiary referral center for high-risk obstetric care. The study period extended from January 2014 to December 2025. Institutional Review Board approval was obtained prior to data collection, and the requirement for informed consent was waived because of the retrospective study design.

During the study period, 16,465 cesarean deliveries were performed at our institution. Patients with documented bladder injury occurring during cesarean delivery were identified through electronic medical records, operative reports, and urology consultation records. A total of 73 patients with confirmed bladder injury were included in the final analysis.

Data collection

Clinical and demographic data were extracted from standardized medical records and electronic hospital databases. Collected variables included maternal age, gravidity, parity, number of previous cesarean deliveries, emergency cesarean delivery, placenta previa, PAS, presenting symptoms, timing of injury recognition, management strategy, and postoperative outcomes. Previous cesarean delivery was categorized as <2 and ≥2 prior cesarean deliveries because multiple previous cesarean sections are recognized risk factors for both PAS and surgical complications during repeat cesarean delivery.

Gross hematuria and urinary leakage were recorded as presenting clinical findings. The timing of diagnosis was categorized as intraoperative recognition when the injury was identified during cesarean delivery and postoperative recognition when the diagnosis was established after completion of surgery based on clinical findings and subsequent evaluation.

Management and outcomes

Management strategies were classified as primary surgical repair or conservative management. Clinical outcomes included duration of catheterization, length of hospital stay, reoperation, readmission, vesicovaginal fistula formation, and persistent urinary symptoms during follow-up.

This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.

Statistical Analysis: Patients were divided into two groups according to the timing of injury recognition: intraoperative recognition and postoperative recognition. Continuous variables were expressed as mean±standard deviation (SD) or median (interquartile range [IQR]) or median (range), depending on data distribution. Categorical variables were expressed as number and percentage. Continuous variables were compared using Student's t-test or the Mann-Whitney U test, as appropriate. Categorical variables were analyzed using the chi-square test or Fisher's exact test. All statistical analyses were performed using IBM SPSS Statistics software (IBM Corp., Armonk, NY, USA). A two-sided $p<0.05$ was considered statistically significant.

RESULTS

During the study period, 73 bladder injuries were identified among 16,465 cesarean deliveries, corresponding to an incidence of 0.44%. The mean maternal age was 32.2±4.1 years. Forty-four patients (60.3%) had a history of two or more previous cesarean deliveries, and 18 (24.7%) underwent emergency cesarean delivery. Placenta previa and PAS were present in 43 (58.9%) and 41 (56.2%) patients, respectively. Gross hematuria was observed in 33 patients (45.2%), whereas urinary leakage was documented in 8 (11.0%). Bladder injury was recognized intraoperatively in 61 patients

(83.6%) and postoperatively in 12 patients (16.4%). Primary bladder repair was performed in 63 patients (86.3%), while 10 patients (13.7%) were managed conservatively (Table 1).

Patients with postoperatively recognized injuries were significantly older than those diagnosed intraoperatively (34.6±4.1 vs. 31.7±4.0 years, p=0.03). A history of two or more previous cesarean deliveries was more common among patients with intraoperatively recognized injuries (65.6% vs. 33.3%, p=0.04). Placenta previa and PAS were also significantly more frequent in intraoperative recognition group (65.6% vs. 25.0%, p=0.01 and 62.3% vs. 25.0%, p=0.02, respectively). In contrast, gross hematuria was observed more frequently among patients diagnosed postoperatively (83.3% vs. 37.7%, p=0.005). Rates of emergency cesarean delivery, urinary leakage, and urology consultation were comparable between groups (Table 2).

Management strategies differed markedly according to the timing of recognition. All intraoperatively recognized injuries underwent primary repair, whereas conservative management was performed predominantly among postoperatively recognized injuries (100% vs. 16.7% and 0% vs. 83.3%, respectively; both p<0.001) (Table 2).

Table 1: Baseline characteristics of patients with bladder ınjury during cesarean delivery, (n=73).

Variables	Overall Cohort
Maternal age (in years), mean±SD	32.2±4.1
Gravidity, median (IQR)	2 (1-4)
Parity, median (IQR)	2 (1-3)
<2 previous cesarean deliveries	29 (39.7)
≥2 previous cesarean deliveries	44 (60.3)
Emergency cesarean delivery	18 (24.7)
Placenta previa	43 (58.9)
PAS	41 (56.2)
Gross hematuria	33 (45.2)
Urinary leakage	8 (11.0)
Intraoperative recognition	61 (83.6)
Postoperative recognition	12 (16.4)
Primary bladder repair	63 (86.3)
Conservative management	10 (13.7)
Urology consultation	66 (90.4)
Length of hospital stay (days), median (IQR)	4 (3-10)

*Continuous variables are presented as mean ± standard deviation (SD) or median (interquartile range [IQR]), as appropriate.

Table 2: Comparison of ıntraoperatively and postoperatively recognized bladder ınjuries.

Variables	Intraoperatively recognition, (n=61)	Postoperatively recognition, (n=12)	P value
Maternal age (in years), mean±SD	31.7±4.0	34.6±4.1	0.03
Gravidity, median (IQR)	2	2	0.88
Parity, median (IQR)	2	3	0.09
≥2 previous cesarean deliveries	40 (65.6)	4 (33.3)	0.04
<2 previous cesarean deliveries	21 (34.4)	8 (66.7)	0.04
Emergency cesarean delivery	16 (26.2)	2 (16.7)	0.72
Placenta previa	40 (65.6)	3 (25.0)	0.01
PAS	38 (62.3)	3 (25.0)	0.02
Gross hematuria	23 (37.7)	10 (83.3)	0.005
Urinary leakage	6 (9.8)	2 (16.7)	0.61
Primary repair required	61 (100)	2 (16.7)	<0.001
Conservative management	0 (0)	10 (83.3)	<0.001
Urology consultation	54 (88.5)	12 (100)	0.34
Length of hospital stay, (in dyas) median (IQR)	4	5	0.04

*Continuous variables are presented as mean±SD or median (interquartile range [IQR]), as appropriate.
Categorical variables are presented as number (percentage). Continuous variables were compared using Student's t-test or Mann-Whitney U test. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate.

Table 3: Clinical outcomes according to timing of recognition.

Outcome	Intraoperative recognition, (n=61)	Postoperative recognition, (n=12)	P value
Duration of catheterization, median (min-max), (days)	7 (7-21)	10 (7-21)	0.02
Length of hospital stay, median (min-max), (days)	4 (3-10)	5 (4-30)	0.04
Reoperation	2 (3.3)	3 (25.0)	0.03
Vesicovaginal fistula	1 (1.6)	1 (8.3)	0.30
Persistent urinary symptoms	3 (4.9)	1 (8.3)	>0.99
Readmission	7 (11.5)	6 (50.0)	0.006

*Continuous variables are presented as median (minimum–maximum). Categorical variables are presented as number (percentage). Continuous variables were compared using the Mann-Whitney U test. Categorical variables were compared using Fisher's exact test. Statistical significance was defined as $p<0.05$.

Clinical outcomes according to timing of recognition are summarized in Table 3. Patients diagnosed postoperatively had a longer duration of catheterization (median 10 vs. 7 days, p=0.02) and a longer hospital stay (median 5 vs. 4 days, p=0.04). Reoperation was more frequent among postoperatively recognized injuries (25.0% vs. 3.3%, p=0.03). Similarly, readmission occurred significantly more often in the postoperative recognition group (50.0% vs. 11.5%, p=0.006). Rates of vesicovaginal fistula and persistent urinary symptoms did not differ significantly between groups.

DISCUSSION

In this retrospective study of bladder injuries occurring during cesarean delivery, most injuries were recognized intraoperatively, whereas a smaller proportion were diagnosed postoperatively. Intraoperative recognition was significantly associated with placenta previa, PAS, and multiple previous cesarean deliveries. In contrast, delayed postoperative diagnosis was associated with gross hematuria, longer catheterization duration, prolonged hospitalization, higher reoperation rates, and increased readmission.

The majority of bladder injuries in our cohort (83.6%) were identified during surgery. This finding is consistent with previous studies demonstrating that clinically significant bladder injuries are frequently recognized intraoperatively because of direct visualization of the defect, urinary leakage into the operative field, or disruption of normal anatomical planes.[15,16] Early recognition allows immediate repair and has been associated with favorable outcomes and reduced postoperative morbidity.[12-14] In our series, all intraoperatively recognized injuries underwent primary repair, emphasizing the importance of prompt identification during cesarean delivery.

An important finding of the present study was the strong association between intraoperative recognition and complex obstetric pathology. Patients with PAS and placenta previa were significantly more likely to have injuries identified during surgery. These findings are biologically plausible because abnormal placentation is associated with distortion of the vesicouterine interface, increased vascularity, and dense adhesions that complicate surgical dissection.[6,7] Previous investigations have consistently identified PAS as one of the most important risk factors for lower urinary tract injury during cesarean delivery.[8,9] The high proportion of PAS-associated injuries likely reflects the referral nature of our institution, which serves as a tertiary center for complex placental disorders. More than half of all bladder injuries in our cohort occurred in patients with PAS, highlighting the substantial contribution of abnormal placentation to urological morbidity in tertiary referral centers.

Interestingly, gross hematuria was significantly more common among patients whose injuries were recognized postoperatively. Although hematuria is not specific for bladder injury, it remains one of the most common clinical manifestations of occult lower urinary tract trauma.[17,18] Our findings suggest that persistent or unexplained postoperative hematuria should prompt careful evaluation for bladder injury, particularly when intraoperative recognition has not occurred. Increased awareness of this presentation may facilitate earlier diagnosis and potentially reduce secondary morbidity.

Patients diagnosed postoperatively experienced significantly worse short-term outcomes. Delayed recognition was associated with longer catheterization duration, prolonged hospitalization, higher reoperation rates, and a fourfold increase in readmission. Similar observations have been reported in studies of urological injuries following obstetric and gynecologic surgery, where delayed diagnosis often necessitates additional diagnostic procedures, repeated interventions, and extended follow-up.[11-13] Although the absolute number of severe complications was low in our cohort, these findings emphasize the clinical and economic consequences of missed intraoperative injuries.

Despite these differences, long-term morbidity remained relatively uncommon. Vesicovaginal fistula developed in

only two patients, and persistent urinary symptoms were infrequent. The favorable outcomes observed in our study may be related to the high rate of urological consultation and multidisciplinary management. Early involvement of urologists has been shown to improve diagnostic accuracy and facilitate appropriate management of lower urinary tract injuries.[10,11,14]

The strengths of this study include the relatively large number of bladder injuries collected over a 12-year period and the detailed assessment of recognition patterns and clinical outcomes. In addition, our institution functions as a tertiary referral center for PAS surgery, allowing evaluation of a substantial number of high-risk obstetric cases.

Several limitations should be acknowledged. First, the retrospective design may have introduced information bias and limited the availability of certain clinical variables. Second, the study was conducted at a single tertiary referral center with a high prevalence of PAS, which may limit generalizability to lower-risk populations. Third, the relatively small number of postoperatively recognized injuries restricted statistical power for some subgroup analyses. Finally, management decisions were based on surgeon judgment and institutional practice patterns rather than a standardized treatment protocol.

CONCLUSION

In conclusion, most bladder injuries during cesarean delivery were recognized intraoperatively, particularly in patients with PAS, placenta previa, and multiple previous cesarean deliveries. Delayed postoperative recognition was associated with longer hospitalization, increased reoperation rates, and more frequent readmission. Careful intraoperative assessment and heightened postoperative vigilance in patients presenting with hematuria or urinary symptoms may improve clinical outcomes and reduce the burden of delayed diagnosis.

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Ethical approval: The study was approved by the Institutional Ethics Committee Bursa Yüksek İhtisas Training and Research Hospital (Ethics code: 2024-TBEK 2025/05-05).

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