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The analyses of length and type of bladder injury during cesarean section in patients with or without placenta accreta: a retrospective case-control study

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Abstract

Aim To evaluate the outcomes of patients with bladder injury during cesarean delivery with or without placenta accreta spectrum (PAS).

Materials ant method Retrospective case series of all pregnancies complicated by bladder injury during cesarean delivery were evaluated in a tertiary hospital between January 2018 and December 2023. Data of patients' demographic and obstetric parameters including bladder injury, such as length and degree of bladder injury, time of bladder injury occurrence (during entrance of peritoneal cavity, bladder flap dissection, uterine incision, or delivery) were all recorded. Patients with bladder injury were also divided into two group as with PAS (+) or without PAS (-), recorded data were compared between groups.

Results Bladder injury was detected in 72 (0.02%) of 35,465 total cesarean section operations. There were 45 (7.5%) patients with bladder injuries in the PAS group. The mean length of bladder injury (cm) in PAS (+) group and PAS (-) group were 5.20 ± 1.98 and 3.74 ± 1.63, respectively ($p = 0.002$). The gestational age at delivery and birth weight were significantly higher in PAS (-) group, while hospital stay was longer in PAS (+) group. The occurrence of bladder injury during flap dissection was significantly higher in PAS (+) group. However, in PAS (-) group the bladder injury during uterine incision or delivery was significantly higher ($p < 0.001$). The bladder injury rates in emergency cesarean sections were higher in two groups than elective cases.

Conclusions The risk of bladder injury is higher in emergency cesarean sections, regardless of PAS status. Longer and more severe bladder injuries are seen in the PAS group.

Keywords Bladder injury, Cesarean delivery, Placenta accreta spectrum

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Introduction

Cesarean section (CS) is one of the most commonly performed surgical procedures globally, and the literature indicates the increase in the frequency of this operation [1]. Consequently, the rising rates of CS are correlated with an increase in the number of patients with a previous CS. In these patients, the likelihood of intra-abdominal adhesions and placenta accreta spectrum (PAS) complications increases in subsequent pregnancies [2, 3]. Iatrogenic bladder injury is a complication that may occur in pelvic operations, including gynecological, general or urological surgeries [4]. Bladder injuries are rare detected as complications of cesarean delivery [5]. The risk of maternal morbidity and PAS are risks of bladder injury during CS, and cesarean hysterectomy has to be performed in most patients for the treatment of PAS [6]. Bladder injury is thought to be a common complication during hysterectomy in PAS, with a frequency ranging from 19 to 27% [7, 8].

Although it is known that bladder injuries are common in PAS surgeries, there was no study comparing this with previous cesarean section and comparing the bladder defect size and time of occurrence of the defect. In our study, we aim to evaluate the bladder injuries in our clinic during CS including PAS cesarean delivery and to make helpful contributions to obstetricians and patients being more aware of this complication in the future.

Materials and methods

Patients

This retrospective case control study was performed in a territory hospital, between January 2018 and December 2023. The study was approved by the ethics committee of University of Health Science Adana City Training and Research Hospital (Date: 21.12.2023, Decision No: 3016).

Cesarean deliveries which performed between these years were scanned from the hospital registry system and patient files. Data of patients' demographic and obstetric parameters including bladder injury, such as length and degree of bladder injury, time of bladder injury occurrence (during entrance of peritoneal cavity, bladder flap dissection, uterine incision, or delivery) were all recorded. The CS was also recorded whether it was urgent (emergency) or planned (elective) according to the obstetric indication. In our hospital, all CS are performed by a senior specialist doctor. The bladder injuries were diagnosed during CS or in the postoperative period before the patient was discharged.

Data collection

Demographic data such as maternal age, body mass index (BMI), gravida, parity, number of previous cesarean deliveries were recorded for all patients, and obstetric outcomes such as gestational age at delivery, indication for cesarean delivery (elective or emergency), cervical dilatation length, length of hospital stay and birth weight, APGAR scores at 1st and 5th minutes were all recorded. The rate of cesarean hysterectomies in PAS surgery was also analyzed.

In terms of bladder injury, the length (cm) and grade of bladder injury and the time of bladder injury detection (intraoperative or postoperative) and time of injury occurrence (during entrance into the peritoneal cavity, during bladder flap dissection or during uterine incision or delivery) was detected from patients' files and operational notes.

Bladder injury was graded according to the American Association for the Surgery of Trauma [9] as follows:

- Grade I, contusion, intramural hematoma, or partial thickness laceration;
- Grade II, extraperitoneal bladder wall laceration ≤ 2 cm;
- Grade III, extraperitoneal (> 2 cm) or intraperitoneal (≤ 2 cm) bladder wall lacerations;
- Grade IV, intraperitoneal bladder wall laceration > 2 cm;
- Grade V, intra- or extraperitoneal bladder wall laceration extending into the bladder neck or ureteral orifice (trigone).

The bladder injury in this study was graded regarding above bladder injury classification.

Our clinic is a tertiary regional hospital and most of the PAS surgeries in our region are performed in our hospital. We usually admit PAS patients to our hospital after the 32nd gestational week for elective surgery preparation. Magnetic resonance imaging is performed to evaluate placental invasion in patients. Additionally, 4 units of erythrocyte suspension and 4 units of fresh frozen plasma are prepared for surgery preparation. Patients with placental invasion are operated electively in the 34th -36th gestational week. After detailed information about PAS surgery a mutual decision by the patient and their relatives are considered. Then the operation is set up by entering the abdomen with a median incision below the umbilicus in patients who do not plan to have uterine preserving surgery. Then, the baby is delivered with a medial vertical incision from the fundus. The placental cord is ligated and thrown back into the uterus and the fundal incision is sutured to reduce bleeding. Finally, the hysterectomy is performed (Fig. 1).

Patients with bladder injuries were followed up with bladder catheterization for 2 weeks after repair by urology. At the end of the second week, bladder catheterizations were performed under cystogram guidance.

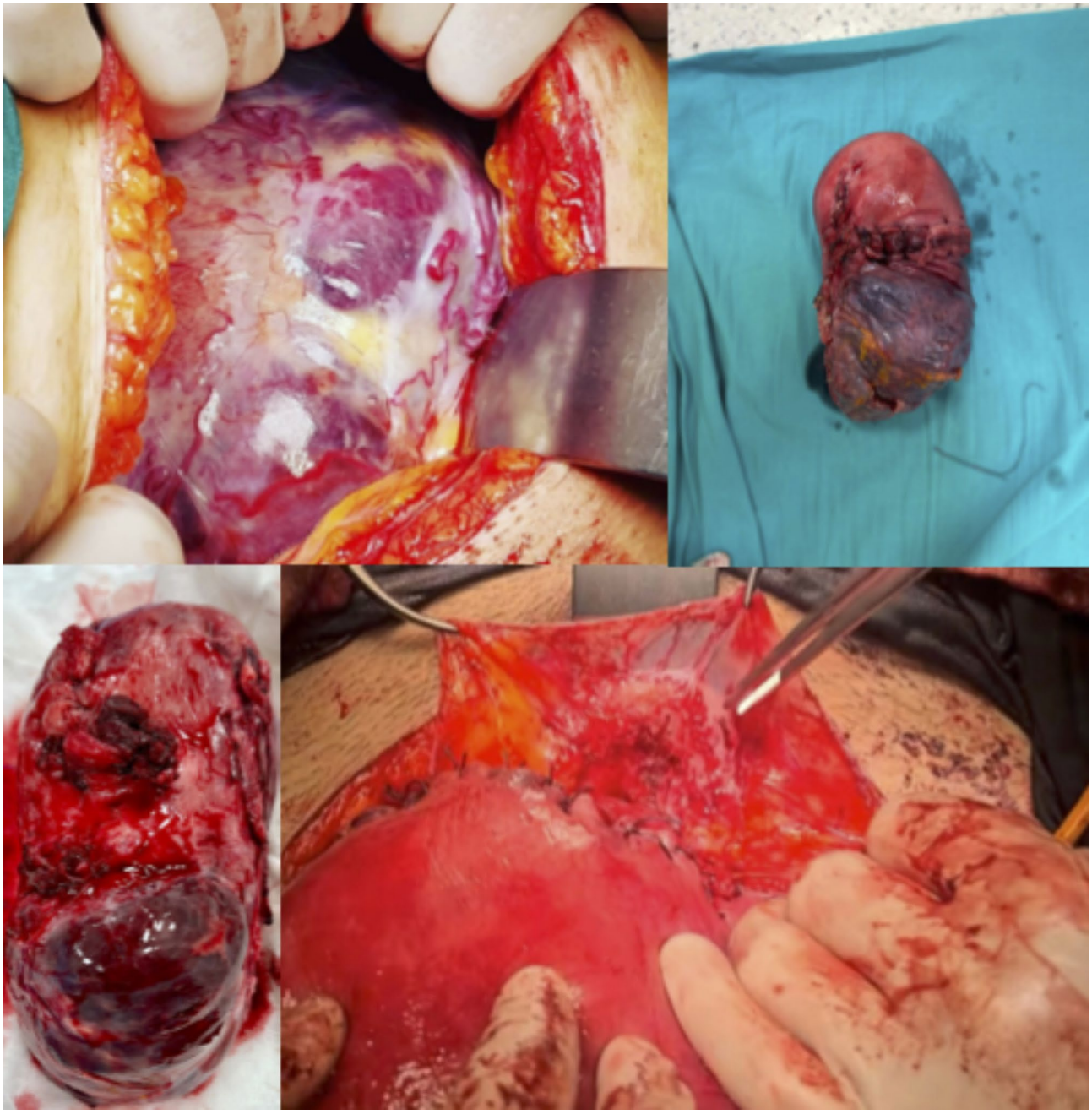

Fig. 1 The images of the surgeries

Statistical analysis

We used the Shapiro-Wilk test to find out whether continuous data were normally distributed. While mean ± standard deviation was used for normally distributed continuous variables, median [25-75%] was used for others. Categorical variables were collected as numbers and percentages. The Chi-square test was used to compare proportions between groups. In the comparison of two independent groups, the Mann-Whitney U test was used if there was no normal distribution, and the Independent Samples t-test was used if there was. We accepted $p < 0.05$ as statistically significant. A logistic regression analysis was used to investigate the associations between PAS and bladder injury length in cm. The odds ratio (OR) and its 95% confidence interval were calculated.

Results

A total of 35,465 cesarean sections were performed during the study period. A total of 75 cases with bladder injuries were collected. Three cases were excluded from

the study due to missing data. A total of 72 patients with bladder injuries were included in the study. Patients with bladder injury were divided into two group regarding PAS positive PAS (+) or negative PAS (-). Recorded data were compared between groups. The flowchart of the patients was shown in Fig. 2. Our hospital is one of the reference hospital centers in south field where high-risk pregnancies are delivered. Bladder injuries were diagnosed during CS in 72 (0.02%) patients. During the study period, 45 (0.13%) of the bladder injuries occurred in PAS (+) patients and 27 (0.07%) in PAS (-) patients. In addition, there were 601 patients diagnosed with PAS (+) during

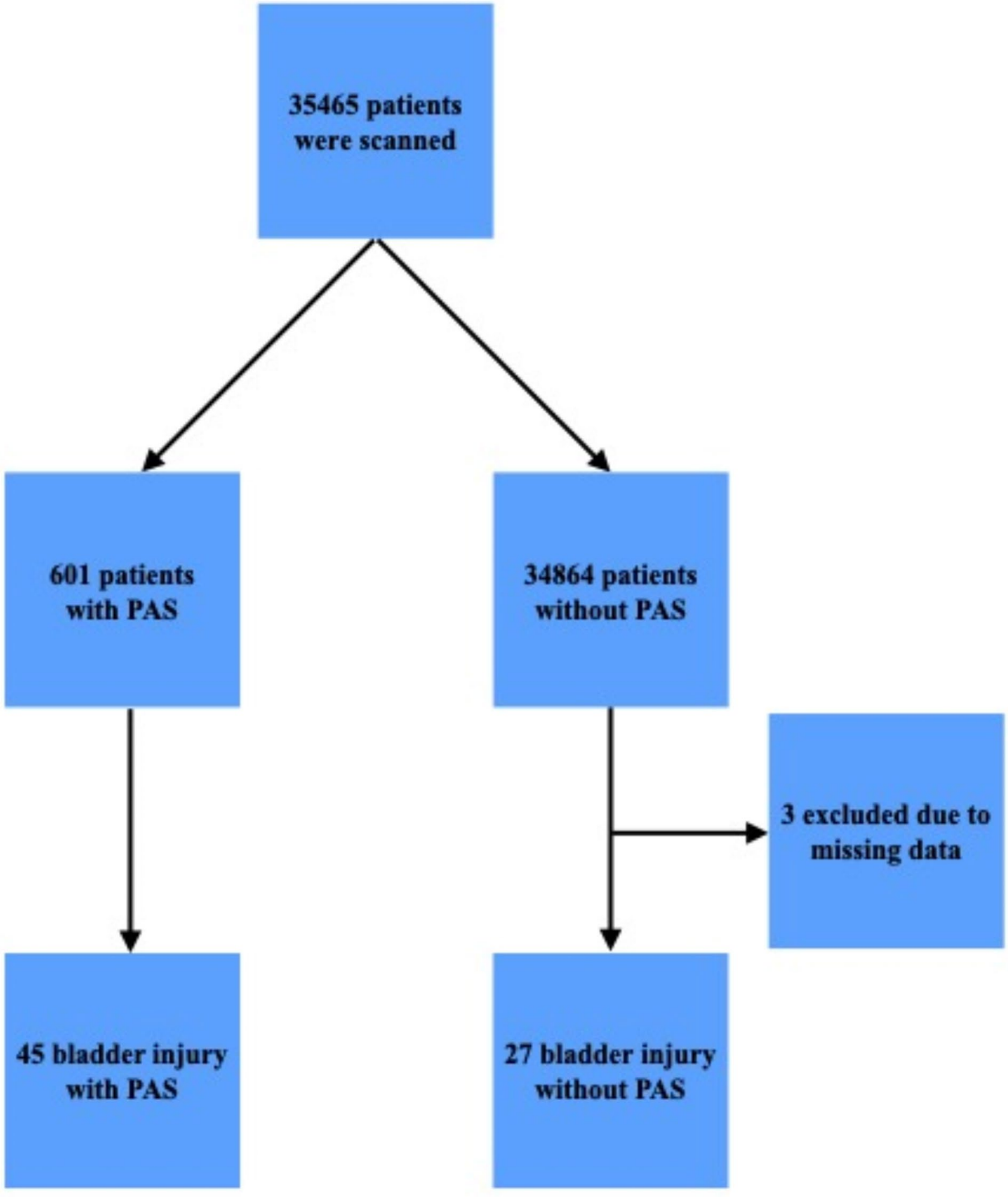

Fig. 2 Patients selection flow chart

the study period, 201 of whom underwent cesarean hysterectomy. A total of 45 (7.5%) patients in the PAS group had bladder injuries, 41 (20.3%) of which occurred during hysterectomy. We showed demographic and obstetrics characteristics of the patients in Table 1. There was no significant difference in terms of age, BMI, gravida, parity, previous cesarean delivery, cervical dilatation and APGAR scores values between groups. The gestational age at delivery, birth weight and duration of hospital stay values was significantly higher in PAS (+) group. Emergency cesarean delivery indication was higher in both groups in patients with bladder injury. Cesarean hysterectomy rate was found higher in PAS (+) as expected.

Bladder injury data of patients was showed in Table 2. The mean bladder injury length was 5.20 ± 1.98 and 3.74 ± 1.63 cm; in PAS (+) group and PAS (-) group; respectively. The bladder injury length was significantly longer in PAS [4] group ($p = 0.002$). In addition, the grade III injury was found statically significantly higher in PAS (+) group ($p = 0.047$).

Regarding the time to be noticed of bladder injury was detected intraoperatively in 44 (97.8%) patients and postoperatively in 1 (2.2%) patient in the PAS (+) group, while it was detected intraoperatively in 24 (89.9%) patients and postoperatively in 3 (11.1%) patients in the PAS (-) group. There was no statistically significant difference between groups ($p = 0.111$).

The bladder injuries that occurred during emergency CS, was found in 41 (81.9%) group 1 (PAS +) and 19 (70.4%) in group 2 (PAS -). While bladder injury length was statistically significant when included in the logistic regression analysis alone, it lost its statistical significance when included in the model with cesarean hysterectomy (Table 3). This may be due to the statistically significant difference between the cesarean hysterectomy groups in terms of bladder injury length. ($p = 0.008$) (Table 4).

Only 1 patient from the PAS (+) group who had hysterectomy developed vesicovaginal fistula and this patient was reoperated.

Discussion

In this retrospective study, grade III and longer length of bladder injury were found significantly higher during CS with PAS (+) patients. The reported incidence of bladder injury in CSs range from 0.0016 to 0.96% [10]. Iatrogenic bladder injury occurred in our study was 0.02% of

Table 1 Demographic and obstetrics parameters of patients

	PAS (+) GROUP *n* = 45	PAS (-) GROUP *n* = 27	*p*
Age (years)	33.75 ± 5.07	33.62 ± 4.87	0.918
BMI (kg/m2)	28.14 ± 4.00	27.36 ± 3.53	0.402
Gravida	5 [4-6.5]	4 [3–5]	0.224
Parity	3 [3–4]	3 [2–4]	0.180
Gestational age at delivery (weeks)	33.42 ± 4.14	37.14 ± 2.56	< 0.001
Previous cesarean delivery	2.86 ± 1.15	2.51 ± 1.08	0.211
Number of previous cesarean delivery			
0	1 (3.7%) [a]	0 (0%) [a]	0.438
1	3 (11.1%) [a]	7 (15.5%) [a]	
2	9 (33.4%) [a]	8 (17.8%) [a]	
3	10 (37%) [a]	18 (40%) [a]	
4	3 (11.1%) [a]	8 (17.8%) [a]	
5	1 (3.7%) [a]	4 (8.9%) [a]	
Cesarean delivery indication (%)			
Elective	4 (8.9%) [a]	8 (29.6%) [b]	0.022
Emergency	41 (81.9%) [a]	19 (70.4%) [b]	
Cervical dilatation (cm)	0 [0–0]	0 [0–0]	0.136
Hospital stays (days)	7 [5–12]	4 [7–8]	< 0.001
Apgar 1. minute	8 [7–8]	8 [7–8]	0.612
Apgar 5. minute	9 [9–10]	9 [9–10]	0.927
Birth weight (g)	2480.88 ± 823.48	3190.70 ± 575.25	< 0.001
Cesarean hysterectomy			
(+)	41 (91.1%) [a]	1 (3.7%) [b]	< 0.001
(-)	4 (8.9%) [a]	26 (96.3%) [b]	

PAS: Placenta accrete spectrum

Continuous data were summarized with mean ± standard deviation and median [25-75%], Independent Samples T-test was used to compare continuous variables with normal distribution, and Mann-Whitney U test was used for non-normal variables. Categorical variables were collected as numbers and percentages. The Chi-square test was used to compare proportions between groups. $p < 0.05$ was consider to be statistically significant. Different superscripts indicate significant mean differences

Table 2 Bladder injury data of patients

	PAS (+) GROUP *n* = 45	PAS (-) GROUP *n* = 27	*p*
Bladder injury length (cm)	5.20 ± 1.98	3.74 ± 1.63	0.002
Grade of iatrogenic bladder injuries (%)			
I	2 (4.4%) [a]	1 (3.7%) [a]	0.047
II	3 (6.7%) [a]	0 (0%) [a]	
III	2 (4.4%) [a]	6 (22.2%) [b]	
IV	33 (73.3%) [a]	20 (74.1%) [a]	
V	5 (11.1%) [a]	0 (0%) [a]	
Time of bladder injury detection			
Intraoperative	44 (97.8%) [a]	24 (89.9%) [a]	0.111
Postoperative	1 (2.2%) [a]	3 (11.1%) [a]	
Time of bladder injury occur			
Entry into the peritoneal cavity	3 (6.6%) [a]	7 (26%) [b]	< 0.001
During bladder flap dissection	42 (93.4%) [a]	5 (18.5%) [b]	
During uterine incision or delivery	0 (0%) [a]	15 (55.5%) [b]	

PAS: Placenta accrete spectrum

Continuous data were summarized with mean ± standard deviation, Independent Samples T-test was used to compare continuous variables with normal distribution, Categorical variables were collected as numbers and percentages. The Chi-square test was used to compare proportions between groups. $p < 0.05$ was consider to be statistically significant. Different superscripts indicate significant mean differences

Table 3 Logistic regression analysis of bladder injury length related to PAS

Variable	OR (95% C.I. for odds ratio)	*p*
Bladder injury length	1.557 (1.154-2.100)	0.004
Bladder injury length	1.737(0.915–3.297)	0.092
Cesarean hysterectomy (Multiple logistic regression)	302.07(25.34-3600.40)	< 0.001

OR: Odds ratio, C.I.: Confidence interval

A logistic regression analysis was used to investigate the associations between PAS and bladder injury length in cm

CSs similar to the literature. Bladder injury is considered a prevalent complication during hysterectomy in PAS, occurring with a frequency of 19–27% [7, 8]. In our study, this rate was 20.3% during hysterectomy in PAS patients.

The rising incidence of recurrent cesarean operations elevates maternal morbidity and mortality rates [11]. One of the most important reasons for this mortality and morbidity, is the increased risk of PAS disorders due to the increasing rate of CS [12]. Furthermore, even in the absence of PAS resulting from recurrent CS, iatrogenic injuries to adjacent organs may arise during the surgical procedure due to the presence of intra-abdominal adhesions. In PAS, prenatal diagnosis and multidisciplinary surgical planning are very important to reduce the risks that may occur as a result of delivery [13]. The treatment for PAS is uterine-preserving surgery or hysterectomy [8]. The infiltration of the bladder by newly formed vessels associated with PAS and the presence of fibrosis resulted in the displacement of the dissection area between the bladder and the uterus from its typical anatomical position, are thought to be the elevating the risk of bladder injury [14, 15]. Bladder injuries predominantly occur during bladder flap dissection (43%). Secondly entrance into the peritoneal cavity (33%) was found, and the remaining injuries consists of injuries after uterine incision or during delivery of the baby in patients with PAS [16]. In addition, bladder injury during these stages of the operation may also occur in patients with a previous cesarean section who are PAS (-). In our study, the most common bladder injury in PAS (+) patients occurred during bladder flap dissection and in PAS (-) patients during uterine incision or delivery of the baby. Cesarean hysterectomy is needed in most cases of PAS, so the dissection of bladder is important for this hysterectomy procedure [17, 18]. Therefore, the higher rates of injuries during bladder flap dissection were not a surprising result of the study. Also, Erfani et al. found that greater depth of invasion in placenta accreta spectrum was associated with more frequent and severe adverse urologic events [7].

The tissue in the area of repeated cesarean incision gets thinner, so this leads higher injuries during the first incision of the uterus or during delivery of the baby.

Table 4 Comparison of bladder injury length in patients with and without Cesarean hysterectomy

	Cesarean hysterectomy (+) *n* = 42	Cesarean hysterectomy (-) *n* = 30	*p*
Bladder injury length (cm)	5.16 ± 2.07	3.93 ± 1.61	0.008

Continuous data were summarized with mean ± standard deviation, Independent Samples T-test was used to compare continuous variables with normal distribution. $p < 0.05$ was consider to be statistically significant

Moreover, the adhesions also more common between bladder and cesarean section incision.

In our study, no difference was observed between the two groups in terms of the number of previous cesarean sections. Many studies have shown the relationship of bladder injury between growing number of previous cesarean deliveries and increased intraabdominal adhesions [11, 19, 20]. These are expected risk factors of bladder injury. Abdelazim et al. found that women with >3 repeated CS were 5 times more likely to have bladder injury (odds ratio 5.0 (95% CI; 0.035–711.8)) than women with one previous CS [11]. Phipps et al. reported that a history of repeated cesarean section was a risk factor for bladder injury and concluded that patients should be informed in detail about this by their obstetrician [21]. Additionally, the number of previous cesarean sections was found to be associated with bladder injury in PAS cases. In the study conducted by Friedrich et al. in PAS cases, the number of previous cesarean sections was found to be a risk factor that increases the risk of bladder injury [22]. In our study, the length of bladder injury was statistically higher in the PAS (+) patient group, and also logistic regression analysis showed that the bladder injury length was 1.5 times more (odds ratio 1.557 (95% CI; 1.154-2.100)) in patients with PAS compared to patients without PAS, but it lost its statistical significance when included in the model with cesarean hysterectomy.

Every obstetrician often has to perform emergency CS, and emergency CS may have an increased risk of complications such as injury of adjacent organs including bladder, intestines or omentum. Bladder injury was shown more frequently in cases that performed emergency CS [23]. Phipps et al., also found higher rates of bladder injury during urgently performed CSs than elective CS [20]. In our study, bladder injuries occurring during CS in both PAS (+) and PAS (-) patients were found to be higher in emergency CS. We believe that creating a bladder flap by performing a lateral dissection parallel to the round ligament level and cauterizing and cutting abnormal vascularization with bipolar instruments instead of blunt dissection will both reduce bleeding and minimize the risk of bladder injury. In addition, rapid interventions due to bleeding may increase the risk of complications. Interventions should be made more calmly and in a controlled manner.

Moreover, Orsi et al. revealed that subtotal hysterectomy could be considered in selected cases to reduce the risk of urological injuries [24].

The gestational age at delivery and birth weight were significantly higher in PAS (-) group, while hospital stay was longer in PAS (+) group. The delivery of patients with suspicious of PAS should not be later than gestational weeks of 34–36 weeks. So, this should be the answer of the lower birth weight and gestational ages in PAS (+) group. In addition, drainage pipes are commonly used in PAS (+) cases so this may extend the stay in the hospital.

The strengths of our study are the large case series of CS in a single center and comparisons of bladder injury as a length dataset between PAS (+) and PAS (-). Our main limitation is the retrospective design of the study and the possibility that bladder injury may be related to surgical experience, but this relationship was reduced as much as possible since it was in a single-center study. Although we planned all PAS cases under elective conditions, bladder injuries that may occur in PAS cases operated on by different teams under emergency conditions during shifts are another limitation of our study.

Conclusion

Iatrogenic bladder injuries, although there is no consensus due to infrequent occurrences associated with CSs, remain a significant concern for obstetricians due to the rising rates of cesarean births. Moreover, the incidence of pregnancies with the possibility of PAS is increasing due to the increasing CS rates. The risk of bladder injury is higher in emergency cesarean sections, regardless of PAS status. Longer and more severe bladder injuries are seen in the PAS group. Therefore, both patients and surgeons should be aware of this high risk.

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Author contributions
All authors listed have made a substantial, direct, and intellectual contribution to the work as follow: Conceptualization, C.A. and G.U.; methodology, M.A.K., and G.U.; software, F.I.A.; formal analysis, F.I.A. and M.A.K.; investigation, M.A.K. and C.A.; resources, G.U.; responsible for data collection, M.A.K.; data curation, M.A.K.; writing-original draft preparation, G.U., F.I.A.; writing-review and editing, G.U., F.I.A.; visualization, F.I.A., C.A; supervision, G.U. All authors have read and agreed to the published version of the manuscript.

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Data availability
Derived data supporting the findings of this study are available from the corresponding author.

Declarations

Ethics approval and consent to participate
The written were informed consent from all participants. The study was approved by the ethics committee of University of Health Science Adana City Training and Research Hospital (Date: 21.12.2023, Decision No: 3016).

Consent for publication
Not appliable.

Competing interests
The authors declare no competing interests.

CONSORT statement
Our study adheres to CONSORT guidelines.

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