PREDICTORS FACTORS OF BLADDER INJURY IN PLACENTA ACCRETA SPECTRUM SURGERY AT A TERTIARY HOSPITAL

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ABSTRACT

Objective: *This study aims to determine the predictors factors associated to bladder injury sustained following placenta accreta spectrum surgeries.* ***Material & Methods:*** *This retrospective cohort study was conducted at the Saiful Anwar General Hospital from 2020-2024. Pregnant women with PAS undergoing hysterectomy or caesarean deliveries were included in the study population. Age, gestational age, number of previous cesarean deliveries, and placenta acreta index (PAI) Score were recorded. Univariate and multivariate analyses were performed to compare women with and without operative bladder injuries.* ***Results:*** *A total of 112 women were included in the study. The incidence of bladder injuries was 10,7%. Preoperative ultrasound examinations revealed an 84% concordance rate with surgical findings, confirming the diagnosis of placenta accreta spectrum. The average age of pregnant women with PAS was 33.71 ±4.66years, with the most common age range being 31-35 years (34.8%). In univariate analysis, gestational age, number of prior cesarean section, and PAI score include lacuna grade, myometrial thickness, and bridging vessel associated with risk of bladder injury. However, the number of prior cesarean sections and myometrial thickness measured by PAI showed a significant association in multivariate analysis.* ***Conclusion:*** *PAS condition carries a risk of bladder injury during surgery. Predictors factors associated to bladder injury of PAS cases include the number of prior cesarean section and myometrial thickness in PAI.*

Keywords: *Bladder injury, placenta accreta spectrum, predictors factors.*

ABSTRAK

Tujuan: *Studi ini bertujuan untuk menentukan faktor-faktor prediktif yang terkait dengan kerusakan kandung kemih yang terjadi setelah operasi spektrum placenta accreta.* ***Bahan & Cara:*** *Studi kohort retrospektif ini dilakukan di Rumah Sakit Umum Saiful Anwar pada periode 2020-2024. Wanita hamil dengan SPA yang menjalani histerektomi atau persalinan caesar dimasukkan ke dalam populasi studi. Usia, usia kehamilan, jumlah persalinan caesar sebelumnya, dan Skor placenta acreta index (PAI) dicatat. Analisis univariat dan multivariat dilakukan untuk membandingkan wanita dengan dan tanpa cedera kandung kemih operatif.* ***Hasil:*** *Sebanyak 112 wanita termasuk dalam studi ini. Insidensi cedera kandung kemih sebesar 10,7%. Pemeriksaan ultrasonografi praoperasi menunjukkan tingkat kesesuaian 84% dengan temuan bedah, yang mengonfirmasi diagnosis spektrum placenta accreta. Usia rata-rata wanita hamil dengan SPA adalah 33,71±4,66 tahun, dengan rentang usia paling umum 31-35 tahun (34,8%). Dalam analisis univariat, usia kehamilan, jumlah operasi caesar sebelumnya, dan skor indeks PAI yang mencakup derajat lacuna, ketebalan miometrium, dan pembuluh darah jembatan terkait dengan risiko cedera kandung kemih. Namun, jumlah operasi caesar sebelumnya dan ketebalan miometrium yang diukur oleh PAI menunjukkan hubungan yang signifikan dalam analisis multivariat.* ***Simpulan:*** *Kondisi PAS membawa risiko cedera kandung kemih selama operasi. Faktor prediktor yang terkait dengan cedera kandung kemih pada kasus SPA meliputi jumlah operasi caesar sebelumnya dan ketebalan miometrium dalam PAI.*

Kata kunci: *Cedera kandung kemih, spektrum placenta accreta, faktor predictor.*

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INTRODUCTION

Placenta accreta spectrum (PAS) refers to a group of disorders characterized by the abnormal invasion of placental tissue into the myometrium. In severe cases, this invasive growth can extend to other nearby organs, such as the bladder and rectum.[1-2] PAS is notably linked with significant maternal morbidity

and mortality, primarily due to severe haemorrhaging during and after childbirth.[3] Additionally, urologic injury is a major complication, often resulting from the direct invasion of tissues and the complex surgical procedures needed to manage PAS. This condition frequently extends beyond the uterus, with the bladder being the most commonly affected organ. While direct invasion of the ureter is rare, the surgical removal of invasive placental tissue from the retroperitoneal space can lead to inadvertent ureteral injury.[4]

Surgical interventions for PAS are associated with numerous complications, with bladder damage being the most common, occurring in 19% to 27% of cases.[5-6] This highlights the intricate nature of PAS management and the critical need for skilled surgical intervention to minimize these risks. A systematic review reported that unintentional urologic injuries occur in 29% of hysterectomies performed for placenta accreta spectrum (PAS). Of these injuries, 78% involve the bladder, and 17% affect the ureter.[7] Current guidelines emphasize the importance of a multidisciplinary approach in managing PAS cases. This approach includes the involvement of urologists, who can play a crucial role in reducing the incidence of such injuries.[8]

The heightened risk of urologic complications in women with placenta accreta spectrum (PAS) is due to several factors. These include extensive neovascularization, fibrosis, and the absence of a clear separation between the anterior lower uterine wall and the posterior bladder. Additionally, the distorted pelvic anatomy often seen in PAS cases contributes to this increased risk.[9,10] Accurate prenatal diagnosis and staging of PAS are critical. These steps allow for better risk stratification of surgical outcomes prior to delivery and can significantly mitigate maternal morbidity. By enabling the planning of a more individualized surgical approach, healthcare providers can better manage the complexities of PAS.[11,12]

OBJECTIVE

This study aims to identify the factors that predict bladder injury in patients undergoing surgery for placenta accreta spectrum, with the goal of improving surgical planning and outcomes.

MATERIAL &METHODS

This retrospective study was conducted at a single tertiary center and was approved by the Health Research Ethics Commission of Saiful Anwar General Hospital Number: 400/177/K.3/302/2023. The medical records of women diagnosed with PAS during caesarean deliveries between January 2020 and April 2024 were examined. PAS was clinically defined by any of the following criteria: (1) absence of a complete separation plane between the placenta and the uterus, (2) unsuccessful gentle manual attempts to remove the placenta, (3) visual evidence of uterine placental invasion during surgery as determined by the lead surgeon, or (4) histological confirmation of PAS.

We compared women who experienced intraoperative bladder injury with those who did not. Additionally, a sub-analysis was performed on women who were not suspected of bladder invasion based on prenatal ultrasound. Bladder injury was defined as the occurrence of either intentional or unintentional cystotomy. The study recorded data on patient age, gestational age, the number of prior cesarean deliveries, and PAI scores. This study does not include any research involving human participants or animals conducted by any of the authors.

Univariate analysis was performed using the $\chi 2$ test and Fisher's exact test, as appropriate for variable analysis. Data were presented as mean and standard deviation for continuous variables and as proportions for categorical variables. Multivariable regression analysis was conducted to identify independent factors associated with bladder injury. The regression model included all factors that were statistically significant in the univariate analysis and clinically relevant. A two-sided P value of less than 0.05 was considered statistically significant. Data analysis was performed using SPSS version 27 (IBM Corp).

RESULTS

A total of 112 women were included in the study. Sample characteristic of the study show in Table 1.The diagnosis of suspect placenta accreta spectrum in our hospital shows that USG and MRI give 100% accuracy for detection and USG only 84% accuracy. The performance of imaging is shown inTable 2.The analysis used a Chi-square test to

examine the influence of various risk factors on bladder trauma (Table 3). The results indicated that age, categorized as ≥ 35 years or <35 years, showed no significant association with bladder trauma (p = 0.644), with an odds ratio of 1.33 (CI 95%: 0.40-4.40). In contrast, gestational age exhibited a significant relationship with bladder trauma (p = 0.012), where a gestational age >36 weeks increased the likelihood of bladder trauma by 9.37 times (CI 95%: 1.17-75.35). A history of C-sections (SC), with ≥ 2 prior C-sections, also significantly increased the risk (p = 0.012) with an odds ratio of 9.37 (CI 95%: 1.17-75.35). Similarly, a higher Lacuna Grade (>2) was significantly associated with bladder trauma (p < 0.000), presenting an odds ratio of 19.0 (CI 95%: 4.48-80.63). Myometrial thickness ≤ 1 mm was another significant factor (p < 0.000), increasing the likelihood by 9.5 times (CI 95%: 2.38-37.95). However, the location of placenta implantation showed no significant association (p = 0.480). A positive bridging vessel was significantly linked to bladder trauma (p = 0.045), with an odds ratio of 4.43 (CI 95%: 0.92-21.27). Lastly, a PAI Score ≥ 5 significantly correlated with a higher probability of bladder trauma (p = 0.002), with an odds ratio of 8.89 (CI 95%: 1.85-42.82). In summary, gestational age >36 weeks, history of ≥ 2 C-sections, higher Lacuna Grade, myometrial thickness ≤ 1 mm, positive bridging vessel, and a higher PAI Score were significantly associated with an increased likelihood of bladder trauma, whereas age and placenta implantation location were not significantly related.

The Spearman correlation test results showed no significant association between age and bladder trauma (p = 0.648, correlation coefficient = 0.044). However, gestational age was significantly associated with bladder trauma (p = 0.012, correlation coefficient = 0.236), with patients >36 weeks of gestation more likely to experience trauma. Similarly, a significant relationship was found between a history of ≥ 2 C-sections and bladder trauma (p = 0.012, correlation coefficient = 0.236).

Lacuna Grade (p < 0.000, correlation coefficient = 0.468) and myometrial thickness ≤ 1 mm (p < 0.000, correlation coefficient = 0.346) were also significantly associated with bladder trauma, indicating higher risks with higher Lacuna Grades and thinner myometrial thickness. No significant correlation was found between placenta implantation location and bladder trauma (p = 0.485, correlation coefficient = 0.067). Bridging vessel presence was significantly related to bladder trauma (p = 0.046, correlation coefficient = 0.189), with positive bridging vessel cases more likely to experience trauma. Finally, a higher PAI Score (≥ 5) showed a significant association with bladder trauma (p = 0.001, correlation coefficient = 0.298).

In this study, multivariate analysis was conducted using logistic regression to examine the relationship between several risk factors and the occurrence of bladder trauma. The overall percentage accuracy of the model was 87.5%, indicating that the independent variables (age, gestational age, history of C-sections, PAI Score, and myometrial thickness) explained 87.5% of the variation in bladder trauma occurrence. The Nagelkerke R-squared value was 0.404, meaning these factors accounted for 40.4% of the variance, with the remaining 59.6% influenced by other factors not included in the study. Using the Backward method in logistic regression, age was excluded in the first step due to a p-value > 0.05, followed by the exclusion of PAI Score in the second step. The final analysis focused on gestational age, history of C-sections, and myometrial thickness as shown in Table 4.

The logistic regression analysis revealed that the constant had a significant impact on the model, with a coefficient of -6.22 and a p-value of 0.004. This indicates that, in the absence of the factors gestational age, history of C-sections, and myometrial thickness, patients have a higher likelihood of experiencing bladder trauma.

For gestational age, the positive regression coefficient (2.10) and p-value of 0.058 suggest no significant influence on bladder trauma (OR = 8.17, CI 95%: 0.93-71.46). Conversely, the history of C-sections (coefficient 2.19, p-value 0.047) significantly impacted bladder trauma, indicating that patients with ≥ 2 C-sections are more likely to experience bladder trauma (OR = 8.96, CI 95%: 1.02-78.39). Myometrial thickness also had a significant impact (coefficient 2.04, p-value 0.006), with patients having a thickness ≤ 1 mm being more prone to bladder trauma (OR = 7.71, CI 95%: 1.78-33.27).

The model's overall accuracy was 89.3%, with Nagelkerke R-squared indicating that 37.6% of the variance in bladder trauma occurrence was explained by gestational age, history of C-sections, and myometrial thickness, while the remaining 62.4% was influenced by other factors.

Table 1. Patient Characteristics.

Sample Characteristic		Frequency	Percentage (%)
Age (yo)			
	mean±SD	33.71±4.66	
	Min-max	23-44	
≥35		49	43.8
<35		63	56.3
Gestational Age (weeks)			
	mean±SD	36.30±2.39	
	Min-max	22-41	
>36		65	58.0
≤36		47	42.0
Radiological Imaging			
USG		88	78.6
USG & MRI		24	21.4
Surgical Finding			
Accreta		81	72.3
Increta		2	1.8
Percreta		15	13.4
Normal		14	12.5
History of SC (times)			
≥2		65	58.0
<2		47	42.0
Lacuna Grade			
	mean±SD	1.63±0.66	
	Min-max	1-3	
>2		11	9.8
≤2		101	90.2
Myometrial Thickness (mm)			
	mean±SD	2.47±1.40	
	Min-max	1-6	
≤1		33	29.5
>1		79	70.5
Placenta Implantation Location			
Anterior		108	96.4
Posterior		4	3.6
Bridging Vessel			
(+)		63	56.3
(-)		49	43.8
PAI Score			
	mean±SD	4.36±2.03	
	Min-max	0.5-9.0	
≥5		46	41.1
<5		66	58.9
Bladder Injury			
Bladder trauma occurred		12	10.7
No bladder trauma occurred		100	89.3

Table 2. Radiological imaging to evaluate for placenta accreta spectrum.

Radiological Imaging	Susp. Placenta Acreta Spectrum (Patients)	Surgical Finding (Patients)		Accuracy (%)
		Placenta Acreta Spectrum	Normal	
USG	88	74	14	84
USG & MRI	24	24	0	100

Table 3. The Univariate Analysis to examine the influence of various risk factors on bladder trauma

Parameter	Bladder Injury (n=12)		No Bladder Injury (n=100)		p-value	odds ratio	95% Confidence Interval	
	n	%	n	%			Lower	Upper
Age (yo)					0.644	1.33	0.40	4.40
≥35	6	50.0	43	43.0				
<35	6	50.0	57	57.0				
Gestational Age (weeks)					0.012	9.37	1.17	75.35
>36	11	91.7	54	54.0				
≤36	1	8.3	46	46.0				
History of SC (times)					0.012	9.37	1.17	75.35
≥2x	11	91.7	54	54.0				
<2x	1	8.3	46	46.0				
Lacuna Grade					0.000	19.00	4.48	80.63
>2	6	50.0	5	5.0				
≤2	6	50.0	95	95.0				
Myometrial Thickness (mm)					0.000	9.50	2.38	37.95
≤1	9	75.0	24	24.0				
>1	3	25.0	76	76.0				
Placenta Implantantion Location					0.480	-		
Anterior	12	100.0	96	96.0				
Posterior	0	0.0	4	4.0				
Bridging Vessel					0.045	4.43	0.92	21.27
(+)	10	83.3	53	53.0				
(-)	2	16.7	47	47.0				
PAI Score					0.002	8.89	1.85	42.82
≥5	10	83.3	36	36.0				
<5	2	16.7	64	64.0				

Table 4. The multivariate analysis used logistic regression to examine the relationship between several risk factors and the occurrence of bladder trauma.

	OR	Sig.	Exp(B)	95,0% C.I.	
				Lower	Upper
Gestational Age	2.10	0.058	8.17	0.93	71.46
History of SC	2.19	0.047	8.96	1.02	78.39
Myometrial Thickness	2.04	0.006	7.71	1.78	33.27
Constant	-6.22	0.004	0.00		

DISCUSSION

Our study included 112 women, with a 10.7% incidence of bladder injury. Preoperative ultrasounds had an 87.5% concordance with surgical PAS findings. The average age was 33.71±4.66 years, most commonly between 31-35 years (34.8%). Univariate analysis linked gestational age, prior cesarean sections, and PAI score components to bladder injury risk. Multivariate analysis found significant associations with the number of prior cesarean sections and myometrial thickness. Placenta accreta with bladder involvement is a rare yet highly severe condition. Antenatal detection of bladder involvement can be challenging, as only a small percentage (5% to 25%) of cases present with gross hematuria. Unlike malignancies, the invasive placental tissue firmly attaches to the bladder wall, causing extensive vascularization rather than penetrating through it. This adherence results in severe hemorrhage during placental separation, leading to critical situations of massive intraoperative bleeding.[13-14]

In alignment with our research, an earlier study demonstrated that higher gestational age was correlated with a decreased risk of injury. Specifically, for each additional week of gestation, the odds of bladder injury were reduced by 60%, highlighting a protective effect as pregnancies progressed further.[15] The association between gestational age and bladder injury during surgery for PAS indicates that as pregnancies advance in gestational age, there is a diminished propensity for sustaining bladder injury. This relationship suggests that pregnancies at later stages are characterized by factors such as improved tissue differentiation and potentially less invasive placental attachment, thereby reducing the likelihood of inadvertent bladder injury during surgical interventions for PAS.[16,17] Placental thickness increases linearly with gestational age, and at 32 to 34 weeks, thickness exceeding 50 mm falls above the 90th percentile. Retrospective studies have linked thicker placenta to PAS development in placenta previa patients. This association may stem from restricted placental migration due to its attachment to the cesarean scar defect, causing a mushroom-like protrusion of the placenta from the defect.[18–20]

Ultrasound and MRI are both noninvasive, nonionizing imaging modalities, each possessing distinct technical and practical advantages for placental imaging. The benefits of each strategy offset the drawbacks of the other. The primary benefits of ultrasonography are superior spatial and temporal resolution relative to MRI, the convenience of functional vascular evaluation via Doppler, and the potential for intraoperative application. The drawbacks of ultrasound, including operator-dependence and restricted penetration and field of view, are mitigated by MRI's consistently expansive field of view imaging. The primary benefit of MRI is its exceptional contrast resolution and tissue-specific characterisation, facilitating a comprehensive view of the placental-myometrial interface. MRI is superior for evaluating extra-uterine invasion and for defining interactions with the pelvic vasculature.[21]

The topography of placental invasion was delineated as the location of placental encroachment within the uterus concerning the posterior bladder wall (including the posterior upper bladder wall and uterine body, posterior lower bladder wall, and lower uterine segment and cervix, or absence of discernible bladder invasion), with the surgical site of invasion regarded as the reference standard. The four examiners demonstrated strong concordance in evaluating the overall presence of aPAS disorder (interrater agreement 92%, Cohen's κ 0.90). Nonetheless, there was considerable variability in interrater agreement when evaluating the various MRI indicators indicative of a PAS condition. The examiners exhibited exceptional concordance in determining the depth of placental invasion on MRI (interrater agreement 99%, Cohen's κ 0.95). Nonetheless, consensus regarding the evaluation of placental invasion topography was merely modest (interrater agreement 73%, Cohen's κ 0.56). Crucially, in evaluating parametrial invasion, a significant factor influencing the intricacy of peripartum management, the concordance was substantial and moderate in determining the presence of invasion in the coronal (interrater agreement 87%, Cohen's κ 0.69) and axial (interrater agreement 79%, Cohen's κ 0.56) planes, respectively. Similarly, interobserver agreement for the assessment of the presence and quantity of newly created vessels in the parametrial tissue was moderate (interrater agreement 88.0%, Cohen's κ 0.59) and fair (interrater agreement 67%, Cohen's κ 0.22), respectively. This study indicates that MRI demonstrates superior interobserver concordance in detecting the existence and severity of PAS problems. Nonetheless, interobserver agreement is diminished on the evaluation of invasion topography, particularly in identifying parametrial

invasion and the presence of neovascularization inside the parametrial tissue, which can substantially influence maternal outcomes. Research indicates that MRI demonstrates superior interobserver concordance in detecting the existence and severity of PAS problems. Nonetheless, interobserver agreement is diminished on the evaluation of invasion topography, particularly in identifying parametrial invasion and the existence of neovascularization inside the parametrial tissue, which can substantially influence maternal outcomes.[21]

In previous studies, it was observed that women with a history of previous cesarean deliveries have a significantly higher risk of bladder injury during subsequent cesarean sections, with the risk tripling compared to those undergoing their first cesarean (0.6% in repeat cesareans versus 0.19% in primary cesarean sections).[22] Another study reported that among patients undergoing multiple cesarean sections, bladder injuries occurred in 0.81% of cases, whereas they were noted in only 0.27% of cases among those having their first cesarean.[23] Within the PAS, urinary bladder injury complicates approximately 11.7% of cesarean deliveries.[24] The primary risk factor for such injuries is the presence of bladder adhesions, which tend to increase in incidence with each subsequent cesarean section. These findings underscore the importance of careful surgical planning and heightened awareness during cesarean deliveries, particularly in women with a history of previous cesarean sections or those diagnosed with PAS.[25,26]

Myometrial thickness plays a critical role in assessing the risk of bladder injury in patients with PAS. In these cases, where the placenta abnormally adheres to the uterine wall, including the previous cesarean scar, thinning of the myometrium increases the likelihood of the placenta invading adjacent structures such as the bladder.[27] A thinner myometrium provides less barrier between the placenta and the bladder, heightening the risk of inadvertent bladder injury during surgical separation. This vulnerability is exacerbated by the firm attachment of placental tissue to surrounding organs, including the bladder, which can lead to severe hemorrhage if the placenta is forcefully separated.[28,29] Therefore, assessing myometrial thickness through ultrasound or imaging techniques is crucial in identifying patients at higher risk of bladder injury during surgical interventions for PAS, guiding surgical planning, and minimizing complications.

Previous systematic review and meta-analysis underscored the limitations of relying solely on myometrial thickness to predict adherent placenta in patients with PAS. While ultrasound markers like bridging vessels and placental lacunae are valuable for detecting invasive placenta, no single parameter, including myometrial thickness, is sufficiently reliable on its own.[30] Studies by Rac et al. and Comstock et al. have highlighted the diagnostic significance of placental lacunae and turbulent flow velocity, respectively, in predicting placenta accreta.[31] Twickler et al. demonstrated 100% sensitivity for myometrial thickness below 1 mm, yet this marker is assigned a lower predictive score compared to higher-grade placental lacunae in the Placenta Accreta Index (PAI).[32] Therefore, a multiparametric approach, such as the PAI, which considers factors ranging from myometrial thickness to placental lacunae grading, is essential for accurately diagnosing placental attachment disorders and assessing the heightened risk of bladder injury in PAS patients.

This research possesses multiple limitations. This study is constrained to a retrospective analysis and was conducted at a single research center. Secondly, not all patients were assessed with MRI, and only select instances were considered when the ultrasound results were inconclusive. The sample size in this investigation was limited due to the constraints of the imaging database at our hospital. The USG comparator and MRI operator should be evaluated to reduce bias between the two observers. Otherwise, this study enhances the concept of multiple imaging study may help early detection of PAS into bladder to avoid the neglected injury of bladder itself.

CONCLUSION

PAS condition carries a significant risk of bladder injury during surgical procedures. Predictive factors associated with bladder injury in PAS cases have been identified, including the number of prior caesarean sections and the less myometrial thickness as indicated by the PAI score. These factors were determined to be influential in the likelihood of sustaining a bladder injury during surgery. Specifically, a higher number of previous cesarean deliveries correlates with an increased risk of bladder injury due to the potential for more extensive scar tissue and adhesions. Additionally, the thickness

of the myometrium, as measured by the PAI score, provides valuable insight into the degree of placental invasion and subsequent risk for urologic complications. This conclusion highlights the importance of careful preoperative assessment and strategic planning in managing PAS cases to mitigate the risk of bladder injury, emphasizing the need for a multidisciplinary approach to improve surgical outcomes and reduce maternal morbidity.

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