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Demographic and Clinical Determinants of Maternal Complications in Cesarean Scar Pregnancy Surgery: A Cross-Sectional Study in Southwestern Iran

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ABSTRACT

Background & Objective: Given the critical importance of timely diagnosis and treatment of cesarean scar pregnancy (CSP) and the lack of comprehensive studies in this field, this study was conducted to investigate the relationship between maternal complications following CSP surgery and various demographic and clinical factors.

Materials & Methods: This cross-sectional study analyzed 350 patients who underwent surgical treatment for CSP at Imam Khomeini Hospital in Ahvaz, Iran, from 2014 to 2023. Demographic and clinical data were collected from medical records. Statistical analyses, including chi-square and t-tests, were performed to assess associations between gestational age, uterine scarring patterns, fetal status, and maternal complications such as blood transfusion, hypervascularity, curettage, laparotomy, hysterectomy, and bladder rupture.

Results: The mean gestational age at diagnosis was 49.58 ± 17.07 days. Intrauterine scarring was the most common (68.57%), and 64.29% of fetuses were deceased at diagnosis. Curettage was the primary intervention (84.29%). Higher gestational age was significantly associated with increased need for packed cell transfusion ($p<0.001$), hypervascularity ($p=0.007$), and laparotomy ($p<0.001$). Uterine scarring patterns were significantly associated with packed cell transfusion, hypervascularity, curettage, and laparotomy ($p<0.001$). Fetal status significantly influenced rates of curettage ($p=0.01$) and laparotomy ($p=0.02$). There were no cases of disseminated intravascular coagulation or maternal death.

Conclusion: Gestational age, uterine scarring patterns, and fetal status are significant factors associated with maternal complications in CSP surgery. Early diagnosis and intervention may reduce the risk of severe complications.

Keywords: Cesarean Section, Postoperative Complications, Gestational Age, Risk Factors

1. Introduction

Cesarean scar pregnancy (CSP) is a rare but dangerous phenomenon in obstetrics (1). This type of pregnancy occurs when a fertilized egg implants not in the uterine cavity but in the scar tissue from a previous cesarean section (2). The current estimated incidence is approximately 1 in every 1,500 cesarean sections performed (2). Although this rate seems low, the consequences are significant, as this condition is a leading cause of maternal mortality in the first trimester (3). CSP is the rarest type of ectopic pregnancy, occurring in approximately 1 in 1,688 to 1 in 1,800 pregnancies and in about 1 in 1,800 to 1 in 2,500 cesarean deliveries (4).

Physicians have identified three types of CSP based on the relationship between the gestational sac and the cesarean scar: Type I, where the gestational sac is fully implanted on the scar with a myometrial thickness greater than 3 mm; Type II, where only part of the sac is implanted with a myometrial thickness less than 3 mm; and Type III, where the sac is completely implanted with a myometrial thickness less than 3 mm (5). The risk of

cesarean scar pregnancy is higher in women with a history of multiple births, repeated cesarean sections, and smoking during the first trimester (6). A study identified several independent risk factors for CSP, including maternal age over 35, gravidity exceeding 3, more than two induced abortions, a short interval (less than 5 years) between the prior cesarean section and the current pregnancy, a history of cesarean section performed in a rural hospital, induced abortions after cesarean section, and retroposition of the uterus (7). Given the serious risks associated with CSP, careful medical monitoring and special care are essential for women with a history of cesarean delivery during subsequent pregnancies (8).

Common symptoms of CSP include amenorrhea and vaginal bleeding (9-11). Other symptoms may include lower abdominal pain and urinary burning sensation (12). CSP can cause uterine rupture and the need for hysterectomy, resulting in severe bleeding and coagulopathy (13-15). These serious potential outcomes underscore the critical importance of early diagnosis and appropriate management of cesarean scar ectopic pregnancies to prevent life-threatening complications and preserve fertility.

As cesarean section rates continue to rise, the incidence of cesarean scar pregnancy (CSP) is also increasing. Early diagnosis of this condition through advanced imaging techniques like ultrasound and MRI allows for timely therapeutic intervention, helping to prevent dangerous and potentially life-threatening complications (2). Given the critical importance of timely diagnosis and treatment of CSP and the lack of comprehensive studies in this field, the primary objective of this study was to examine the relationship between maternal complications resulting from the surgical management of CSP and various demographic and clinical factors, to provide more effective strategies for managing this complex condition.

2. Materials and Methods

The present study was designed as a cross-sectional analysis conducted on patients hospitalized at Imam Khomeini Hospital in Ahvaz for surgical treatment of CSP from 2014 to 2023. Based on ultrasound findings, a census approach was used to systematically review all relevant medical records of patients diagnosed with CSP.

Inclusion criteria encompassed patients diagnosed with CSP based on pelvic ultrasound, confirmation of fetal viability, and classification of the pregnancy type (intrauterine, ectopic, or along the cesarean line) through follow-up ultrasounds. Patients who were candidates for surgical intervention were included in the study. Conversely, exclusion criteria involved patients whose CSP diagnosis was unconfirmed, those who did not undergo surgery, and individuals with incomplete medical records.

Ethical approval for the study was obtained from the Ethics Committee of Jundishapur University of Medical Sciences (IR.AJUMS.REC.1403.061). Data collection involved reviewing medical records of eligible patients during the specified time frame. Information gathered included medical history, ultrasound results, details of surgical procedures performed, and any associated complications.

The following data were collected: Demographic variables: age (years), gravidity (number of pregnancies), parity (number of live births), gestational age at diagnosis (days), and number of prior cesarean deliveries. Clinical characteristics: History of repeated abortions (yes/no), type of previous cesarean sections (elective/emergency), placenta location (anterior, posterior, low-lying, placenta accreta, or unknown), uterine scarring pattern (intrauterine, line, extrauterine), and fetal status (live/deceased). Surgical procedures: type of surgical procedure performed (e.g., curettage, laparotomy/hysterotomy, hysterectomy, laparoscopic resection) and maternal outcomes: need for blood transfusion, curettage, laparotomy/hysterotomy, hysterectomy, bladder rupture (confirmed via cystoscopy or surgical exploration), and maternal death.

Descriptive statistics were used to summarize these demographic and clinical characteristics. Reporting means, standard deviations, and frequency distributions for continuous and categorical variables. The normality of continuous variables was assessed using the Shapiro-Wilk test. To analyze the relationships between uterine scarring patterns, fetal status, and maternal outcomes, chi-square tests were utilized for categorical variables, while independent t-tests were conducted to compare means across different groups. Data analyses were performed using SPSS version 26, with a significance level set at $p < 0.05$ to determine the statistical significance of the findings.

3. Results

Table 1 summarizes the demographic and clinical characteristics of women with CSP in this study. The mean gestational age at diagnosis was 49.58 days (SD = 17.07), ranging from 4 to 98 days. On average, participants had undergone 2.25 previous cesarean sections (SD = 0.96), and the mean BMI of the study population was 30.11 kg/m² (SD = 3.68). The average age of the women in the study was 34.89 years (SD = 4.77), with the youngest being 21 and the oldest 46 years old. Regarding obstetric history, the mean gravidity was 4.06 (SD = 1.39), while the mean parity was 2.4 (SD = 0.99).

Table 1. Summary of demographic and clinical variables in women with CSP

Variable	Mean	SD	Range
Gestational age (day)	49.58	17.07	4, 98
Previous cesarean section count	2.25	0.96	1, 7
BMI (kg/m^2)	30.11	3.68	21, 42
Age (year)	34.89	4.77	21, 46
Gravidity	4.06	1.39	2, 10
Parity	2.4	0.99	1, 6

Table 2 presents the distribution of various clinical characteristics among women with CSP. Most participants (95.43%) had no history of repeated abortions. Previous cesarean sections were predominantly elective (98.57%). Placenta location was unknown in most cases (88.57%, n=310). Among those with known placental locations, 3.71% (n=13) were anterior, 4.29% (n=15) were posterior, 1.14% (n=4) were low-lying, and 2.29% (n=8) were classified as placenta accreta. Uterine scarring was mostly intrauterine (68.57%), followed by line scarring (26.86%) and extrauterine (4.57%). Fetal status was reported as live in 35.71% of cases and decreased in 64.29%.

Table 2. Distribution of clinical characteristics among women with CSP

Variable		Frequency	Percent
Repeated abortion	Yes	16	4.57
	No	334	95.43
Cesarean type	Elective	345	98.57
	Emergency	5	1.43
Placenta location	Unknown	310	88.57
	Anterior	13	3.71
	Posterior	15	4.29
	Low-Lying	4	1.14
	Accreta	8	2.29
Uterine scarring	Intrauterine	240	68.57
	Line	94	26.86
	Extrauterine	16	4.57
Fetal status	Live	125	35.71
	Dead	225	64.29

Table 3 summarizes the maternal outcomes and interventions in women with CSP. Notably, there were no cases of DIC or maternal death. 14.86% of patients required packed cell transfusions. Hysterectomy was performed in 2.29% of cases. Hypervascularity was observed in 11.43% of patients. Curettage was the most common intervention, performed in 84.29% of cases. Laparotomy was necessary for 12.29% of patients, while bladder rupture occurred in 1.43% of cases. Laparoscopic resection of the cesarean scar was performed in 3.45% of patients.

Table 3. Maternal outcomes and interventions in women with CSP

Variable		Frequency	Percent
Need to pack cell	Yes	52	14.86
	No	298	85.14
Hysterectomy	Yes	8	2.29
	No	342	97.71
Hypervascularity	Yes	40	11.43
	No	310	88.57
Curettage	Yes	295	84.29
	No	55	15.71
Laparotomy	Yes	43	12.29
	No	307	87.71
Bladder rapture	Yes	5	1.43
	No	345	98.57
Laparoscopy in resection line	Yes	12	3.45
	No	336	96.55

Table 4 examines the relationships between gestational age, previous cesarean section count, and maternal outcomes in cesarean scar pregnancies. Significant associations were observed between gestational age and several outcomes. As observed, complications are more prevalent in pregnancies beyond eight weeks of gestation. The need for packed cell transfusion ($p<0.001$), presence of hypervascularity ($p=0.007$), and requirement for laparotomy ($p<0.001$) were all associated with higher mean gestational ages. Conversely, cases requiring curettage had a significantly lower mean gestational age ($p<0.001$). There were no significant associations between gestational age and hysterectomy, bladder rupture, or laparoscopy in the resection line. Notably, the number of previous cesarean sections was not significantly associated with any outcomes studied ($p>0.05$).

Table 5 illustrates the relationships between uterine scarring patterns, fetal status, and various maternal outcomes in CSP cases. Significant associations were observed between uterine scarring patterns and the need for packed cell transfusion, hypervascularity, curettage, and laparotomy ($p<0.001$). Line and extrauterine scarring were associated with higher rates of packed cell transfusion and hypervascularity, while intrauterine scarring was associated with higher rates of curettage. Laparotomy was more common in line and extrauterine scarring. Fetal status significantly influenced the rates of curettage ($p=0.01$) and laparotomy ($p=0.02$), with curettage being more frequent in cases of fetal demise and laparotomy more common in cases with live fetuses. There were no significant associations between uterine scarring patterns, fetal status, hysterectomy, bladder rupture, or laparoscopy in the resection line ($p>0.05$).

Table 4. Relationships between gestational age, previous cesarean section count, and maternal outcomes in CSP cases

Variable		Gestational age (day)		Previous cesarean section	
		Mean ± SD	P-Value	Mean ± SD	P-Value
Need to pack cell	Yes	54.69 ± 2.15	<0.001	2.27 ± 1.01	0.89
	No	48.69 ± 9.86		2.25 ± 0.96	
Hysterectomy	Yes	54.88 ± 26.70	0.17	2.38 ± 1.19	0.71
	No	49.46 ± 10.49		2.25 ± 0.96	
Hypervascularity	Yes	54.05 ± 15.44	0.007	2.2 ± 1.09	0.72
	No	49.003 ± 10.27		2.26 ± 0.95	
Curettage	Yes	48.68 ± 9.54	<0.001	2.28 ± 0.98	0.18
	No	54.42 ± 16.37		2.09 ± 0.87	
Laparotomy	Yes	56.37 ± 17.29	<0.001	2.19 ± 0.88	0.64
	No	48.63 ± 9.55		2.26 ± 0.98	
Bladder rapture	Yes	58.2 ± 14.52	0.08	1.6 ± 0.55	0.13
	No	49.46 ± 10.99		2.26 ± 0.97	
Laparoscopy in resection line	Yes	45.33 ± 6.08	0.18	1.92 ± 0.79	0.22
	No	49.67 ± 11.14		2.26 ± 0.97	

Table 5. Relationships between uterine scarring patterns, fetal status, and maternal outcomes in CSP cases

Variable		Uterine scarring				Fetal status		
		Intrauterine	Line	Extrauterine	P-Value	Live	Dead	P-Value
Need to pack cell	Yes	19 (36.54)	27 (51.92)	6 (11.54)	<0.001	24 (46.15)	28 (53.85)	0.09
	No	221 (74.16)	67 (22.48)	10 (3.36)		101 (33.89)	197 (66.11)	
Hysterectomy	Yes	3 (37.5)	4 (50)	1 (12.5)	0.14	2 (25)	6 (75)	0.52
	No	237 (69.3)	90 (26.32)	15 (4.39)		123 (39.96)	219 (64.04)	
Hypervascularity	Yes	16 (40)	17 (42.5)	7 (17.5)	<0.001	19 (47.5)	21 (52.5)	0.1
	No	224 (72.26)	77 (24.84)	9 (2.9)		106 (34.19)	204 (65.81)	
Curettage	Yes	217 (73.56)	71 (24.07)	7 (2.37)	<0.001	97 (32.88)	198 (67.12)	0.01
	No	23 (41.82)	23 (41.82)	9 (16.37)		28 (50.91)	27 (49.09)	
Laparotomy	Yes	17 (39.53)	17 (39.53)	9 (20.93)	<0.001	22 (51.16)	21 (48.84)	0.02
	No	223 (72.64)	77 (25.08)	7 (2.28)		103 (33.55)	204 (66.45)	
Bladder rapture	Yes	2 (40)	2 (40)	1 (20)	0.097	2 (40)	3 (60)	0.99
	No	238 (68.99)	92 (26.67)	15 (4.35)		123 (35.65)	222 (64.35)	
Laparoscopy in resection line	Yes	7 (58.33)	5 (41.67)	0	0.41	6 (50)	6 (50)	0.28
	No	232 (69.05)	88 (26.19)	16 (4.76)		117 (34.82)	219 (65.18)	

4. Discussion

This study was conducted to examine the relationship between maternal complications resulting from the surgical management of CSP and various demographic and clinical factors. Our findings revealed that uterine scarring was predominantly intrauterine (68.57%), and 64.29% of fetuses were deceased at the time of diagnosis. Curettage was the most common intervention, performed in 84.29% of cases. Significant associations were observed between gestational age and the need for packed cell transfusion, hypervascularity, and the requirement for laparotomy. Uterine scarring patterns were significantly associated with the need for packed cell transfusion, hypervascularity, curettage, and laparotomy. Fetal status significantly influenced the rates of curettage and laparotomy.

The absence of DIC and maternal death indicates effective surgical interventions, suggesting that with timely management, serious complications can be avoided. The necessity for packed cell transfusions in 14.86% of patients reflects the potential for hemorrhage, yet this rate is lower than some previous reports, indicating improved outcomes. Hysterectomy was performed in only 2.29% of cases, highlighting the success of less invasive procedures, as curettage was the most common intervention at 84.29%. The occurrence of hypervascularity in 11.43% of patients and laparotomy in 12.29% underscores the need for careful monitoring and intervention planning. Additionally, bladder rupture occurred in 1.43% of cases, emphasizing the risks associated with surgical management. The data also show that laparoscopic resection was performed in 3.45% of patients, reflecting a trend towards minimally invasive techniques.

The Xu et al **(16)** study reported that 8.55% of patients underwent laparoscopic CSP resection, slightly higher than the 3.45% observed in our findings for laparoscopic resection. This discrepancy may reflect differences in clinical practice or patient selection criteria between the two studies. Regarding maternal outcomes, both studies reported low rates of severe complications. The Xu et al **(16)** study indicated that only 8 patients required additional systemic methotrexate treatment, while our study reported no cases of DIC or maternal death. Our findings showed that 14.86% of patients required packed cell transfusions, consistent with the need for careful hemorrhage management as noted in both studies.

Moreover, in the conducted study by Calì et al **(17)**, 69 cases of CSP were managed expectantly, with a notable 13.0% experiencing uncomplicated miscarriages in cases with embryonic/fetal heart activity and 20.0% requiring medical intervention. In contrast, our study reported no cases of maternal death or DIC, highlighting a more favorable outcome in terms of severe complications. While the Calì et al **(17)** study indicated a uterine rupture rate of 9.9% and a hysterectomy requirement of 15.2%, our findings showed a much lower hysterectomy rate of 2.29%, suggesting that less invasive management strategies may be more effective in our cohort. Moreover, while the referenced study noted that 76.9% of women progressed to the third trimester, with 39.2% experiencing severe bleeding, our study found hypervascularity was observed in only 11.43% of patients, indicating potentially lower rates of severe complications in our population.

Our study demonstrated a significant relationship between gestational age and several maternal outcomes. Higher gestational ages were associated with an increased need for packed cell transfusion, the presence of hypervascularity, and the requirement for laparotomy. This finding aligns with previous research by Timor-Tritsch et al **(18)** suggesting that delayed diagnosis and management of CSP can lead to more severe complications (32.2% composite adverse outcome in CSP diagnosed >9 weeks vs. 5.9% in CSP diagnosed ≤9 weeks) **(18)**. De Braud et al **(19)** showed that gestational age ≥ 9 weeks and placental lacunae were associated with major blood loss.

Conversely, in our study, lower gestational ages were associated with a higher likelihood of curettage, possibly due to less advanced pregnancy development, allowing for less invasive interventions. Moreover, recent evidence emphasizes the significance of early first-trimester ultrasound in identifying the most severe complication associated with CSP and predicting surgical outcomes **(20)**.

In other studies, the size of the mass, its vascularity, and the gestational age at diagnosis of CSP were key determinants influencing pregnancy outcomes **(21, 22)**.

The study revealed important associations between uterine scarring patterns and maternal outcomes. Line and extrauterine scarring were linked to higher rates of packed cell transfusion and hypervascularity, while intrauterine scarring was associated with higher rates of curettage. These findings suggest that the location and nature of uterine scarring play a crucial role in determining the course and complications of CSP. This information could be valuable for clinicians in predicting potential complications and planning appropriate interventions based on the specific scarring pattern observed.

Fetal status was found to influence the rates of curettage and laparotomy significantly. Curettage was more frequent in cases of fetal demise, while laparotomy was more common in cases with live fetuses. This association likely reflects the different management approaches required based on fetal viability, with more conservative methods possible in cases of fetal demise.

The findings emphasize the critical importance of early diagnosis and intervention, potentially reducing

life-threatening complications and preserving fertility. Healthcare providers can utilize this information to enhance patient counseling, allowing for more informed decision-making. The study's results may guide surgical planning, helping clinicians choose the most appropriate interventions based on gestational age and uterine scarring patterns.

However, our study has some limitations. First, the retrospective nature of the study design may have introduced potential biases in data collection and interpretation. Second, the study was conducted in a single center, which may limit the generalizability of our findings to other populations or healthcare settings. Third, we could not assess long-term outcomes or fertility rates following CSP management due to the cross-sectional design. Finally, the study lacked information on potentially relevant factors, such as the surgical techniques used in previous cesarean sections or the exact location of the gestational sac within the cesarean scar.

5. Conclusion

This study revealed that various factors are associated with maternal complications following CSP surgery. Higher gestational age was correlated with increased need for blood transfusion, hypervascularity, and laparotomy, while lower gestational age was linked to higher curettage rates. Uterine scar patterns significantly influenced maternal outcomes, with linear and extrauterine scars associated with higher blood transfusion and hypervascularity rates. The fetal status also impacted curettage and laparotomy frequencies. Our study provides valuable insights for clinicians managing CSP cases. By identifying key risk factors associated with specific maternal complications, we can better stratify patients based on their risk profiles. This allows for more tailored management strategies, including earlier intervention in high-risk cases and the selection of the most appropriate surgical approach based on the uterine scarring pattern and fetal status.

6. Declarations

6.1 Acknowledgments

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6.2 Ethical Considerations

Ethical approval for the study was obtained from the Ethics Committee of Jundishapur University of Medical Sciences (IR.AJUMS.REC.1403.061).

6.3 Authors' Contributions

NM.B.: Supervision of the entire research process, Study design and formulation of the research plan, data analysis and interpretation, and drafting of the initial manuscript. R.N.: Assistance in study design, data collection, and critical manuscript review for the scientific content. S.M.: Collaboration in data collection, statistical analysis, and preparation of the initial draft of the manuscript. M.Z.: Data collection, initial manuscript drafting, and correspondence responsibility.

6.4 Conflict of Interest

The authors declare that there are no conflicts of interest.

6.5 Fund or Financial Support

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6.6 Using Artificial Intelligence Tools (AI Tools)

The authors were not utilized AI Tools.

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