Original Research
Single-Center Insights into Cesarean Scar Pregnancy: Treatment Strategies and Determinants

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Abstract

Background: This study aimed to evaluate the effectiveness of different treatments for cesarean scar pregnancy (CSP) and to identify key factors influencing treatment selection, in order to help standardize CSP management. Methods: We retrospectively analyzed data from 220 CSP patients at the Family Planning Department of the Women’s Hospital, School of Medicine, Zhejiang University, from January 2019 to December 2019, adhering to the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines. Treatment methods included dilation and curettage (D&C), curettage after uterine artery embolization (UAE+C), hysterectomy plus curettage (H/S+C), H/S+C following UAE (UAE+H/S+C), and hysterectomy combined with laparoscopic resection (L/S+H/S). We assessed treatment outcomes by evaluating the normalization of serum β-human chorionic gonadotropin (β-hCG) levels, disappearance of the isthmic mass, and the occurrence of complications. Results: No significant difference in treatment success rates was found among the groups (p > 0.05). Larger gestational sac diameter (GSD) and thinner myometrial thickness were significant factors in choosing uterine artery embolization (UAE) (p < 0.05), while thinner myometrial thickness alone was a predictor for selecting H/S+C (p < 0.05). The presence of a fetal heartbeat and the subtype of CSP also influenced the choice of UAE and surgical treatment (p < 0.05). Conclusions: This study highlights the need for personalized treatment plans for CSP, considering factors like GSD, myometrial thickness, heartbeat, and CSP subtype. Although no treatment method proved superior, the study identifies important considerations for treatment selection, emphasizing the importance of individualized care in CSP management. The use of STROBE guidelines ensured comprehensive reporting and analysis, offering valuable insights for CSP treatment.

Keywords: cesarean scar pregnancy; uterine artery embolization; curettage; hysteroscopy; laparoscopy; surgery

1. Introduction

Cesarean scar pregnancy (CSP) occurs when an embryo implants in the lower uterus at the site of a previous cesarean section (CS) scar, affecting women with a history of CS [1]. It represents a specific type of ectopic pregnancy and is considered a long-term complication of CS. Globally, CS rates have been increasing, with over 30% of deliveries conducted via CS in 15 countries as of 2008. In China, the CS rate has consistently remained high, reaching 34.9% according to the 2014 National Maternal and Child Health Annual Report [2]. Due to persistently high CS rates, resulting in the likelihood of experiencing CSP in subsequent pregnancies for women with a history of CS estimated at 1 in 531 [3], and factors such as the relaxation of birth policies, the incidence of CSP in China is on a clear upward trend.

Due to the lack of large-scale studies on the outcomes of continuing pregnancies in patients with CSP, accurately classifying these patients remains challenging. As the pregnancy progresses, the risks of spontaneous bleeding, placental implantation, and uterine rupture significantly increase, especially during the mid to late stages. These complications can require a hysterectomy, eliminating the chance of future pregnancies and potentially endangering the patient’s life. Therefore, it is widely recommended to terminate a CSP as soon as it is diagnosed [4].

To date, no standardized treatment protocol exists for CSP. Treatment plans are typically tailored based on the patient’s overall condition, including clinical symptoms, gestational age (GA), serum β-human chorionic gonadotropin (β-hCG) levels, mass size, CSP classification, and other factors [5,6]. This retrospective study reports on the management of 220 patients diagnosed with CSP at our institution, involving various treatment methods including dilation and curettage (D&C), curettage after uterine artery embolization (UAE+C), hysterectomy plus curettage (H/S+C), H/S+C following UAE (UAE+H/S+C), and hysterectomy combined with laparoscopic resection (L/S+H/S). The primary aim of this study is to analyze the efficacy of different treatment modalities, to identify key determinants in the selection of CSP treatment methods, and explore the feasibility of establishing standardized treatment protocols for CSP based on these findings. Through this approach, we aim to provide clearer and more scientifically grounded guidance for the effective management of CSP, thereby improving patient outcomes.
2. Materials and Methods

2.1 Participants

This study adopts a retrospective design. Considering the nature of the retrospective approach and the anonymization of patient data, approval (IRB-20220061-R) for the study protocol has been granted by the Ethics Committee of Women’s Hospital, School of Medicine, Zhejiang University. Consequently, the necessity of obtaining informed consent from individual patients has been waived. This exemption is due to the low risk posed to participants by the retrospective analysis of anonymized data, which ensures that patient confidentiality and privacy are maintained.

We adhered to the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) reporting guidelines [7] for our methodology, ensuring comprehensive and transparent reporting of our study design and findings.

A total of 282 first-trimester patients diagnosed with CSP were initially identified using the keyword ‘CSP’ from the hospital records database at the Family Planning Department of Women’s Hospital, School of Medicine, Zhejiang University, covering the period from 1st January 2019 to 31st December, 2019. After applying the inclusion and exclusion criteria, 220 patients were ultimately included in the study (Fig. 1).

The inclusion criteria were: (1) a history of cesarean delivery, (2) a history of amenorrhea and a positive pregnancy test, (3) a color Doppler pelvic ultrasound (WS80A, manufactured by Samsung Medison Co., Ltd., Kangwon-do, South Korea) indicating a uterine scar pregnancy, based on the diagnostic criteria recommended by Timor-Tritsch et al. [8], (4) postoperative pathology confirming the presence of chorionic villi.

The exclusion criteria included: (1) lack of complete clinical data, (2) patients initially treated elsewhere and not managed further at our institution.

The patients were categorized into three types based on the “Expert Consensus on the Diagnosis and Treatment of CSP 2016”, formulated by the Family Planning Group of the Chinese Medical Association Obstetrics and Gynecology Branch [9]. Type I: (1) the gestational sac (GS) partially implants in the uterine scar; (2) the myometrial layer between the GS and the bladder becomes thin, with a thickness >3 mm. Type II: (1) the GS partially implants in the uterine scar; (2) the myometrial layer between the GS and the bladder becomes thin, with a thickness ≤3 mm. Type III: (1) the GS completely implants in the muscular layer of the uterine scar and protrudes toward the bladder; (2) the myometrial layer between the GS and the bladder shows significant thinning or even absence, with a thickness ≤3 mm.

2.2 Data Collection

The study collected data by reviewing medical records, including information on maternal age, gravidity, parity, previous D&C, previous CSP, CS frequency, interval since the last CS, GA, presenting symptoms, gestational sac diameter (GSD), embryonic length (EL), fetal heart-beat, myometrial thickness, serum β-hCG levels, treatment methods, blood loss, and treatment costs. All patients presented with normal vital signs and were hemodynamically stable at the time of the diagnosis.

2.3 Treatments

The treatment approach for CSP primarily relies on the attending physician’s expert opinion and may include D&C, UAE+C, H/S+C, UAE+H/S+C, or L/S+H/S. The objective of treatment is to effectively manage CSP, minimize associated trauma, and preserve fertility.

Patients scheduled for uterine artery embolization (UAE) were transferred to a radiological intervention treatment center. Experienced radiologists performed super-selective UAE using gelatin sponge powder containing 60 mg of methotrexate (MTX). Gynecological surgery was performed 24–48 hours post-embolization.

Patients were administered 150 mg of mifepristone orally the day before surgery and 400 µg of misoprostol sublingually 2 hours before the procedure.

D&C was conducted by an experienced gynecologist under ultrasonographic guidance. If necessary, apply iodine-soaked gauze might have been applied to the isthmus for 24 hours postoperatively to minimize bleeding.

The H/S+C procedure involves using a 10 mm hysteroscope. It began with a hysteroscopic examination to locate the GS, followed by vacuum suction aspiration of the GS. A final hysteroscopic check ensured the complete removal of any residual pregnancy material, with minimal use of energy instruments to prevent damage to the thin-walled uterine diverticulum. Iodine-soaked gauze compression at the isthmus might have been applied for 24 hours to reduce postoperative bleeding, if required.

L/S+H/S were utilized when the GS significantly protrudes towards the bladder. Preoperative UAE minimized surgery-related bleeding risk. The procedure involved adhesion separation, incision of the vesicouterine peritoneal fold, bladder retraction, and exposure of the isthmus. Vasopressin (6 U in 20 mL saline) was injected to reduce bleeding before incising the previous cesarean scar. Excised scar and pregnancy tissues were followed by intermittent suturing of the uterine muscle layer with 1–0 absorbable thread and continuous suturing of the serosa. A hysteroscopic examination ensured no residual pregnancy or bleeding in the isthmus.

2.4 Follow-up

Primary treatment success is defined by the normalization of serum β-hCG levels (<5.3 mIU/mL), disappearance of the isthmic mass, and the absence of a need for further intervention (e.g., Foley catheter balloon compression, MTX...
Severe complications are defined as bleeding of >1000 mL or organ damage (e.g., uterine rupture and massive bleeding).

2.5 Statistical Analysis

We performed data statistical analysis using Statistical Package for Social Sciences (SPSS; IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY, USA). Descriptive statistics for the collected research data were presented as mean ± standard deviation (SD) values for normally distributed continuous variables, as median with minimum-maximum values for non-normally distributed continuous variables, and as numbers and percentage values for categorical variables. The one-way analysis of variance (ANOVA) test was used to analyze normally distributed variables, while the Kruskal-Wallis test was applied for variables that did not meet the assumptions of normality. Pearson’s Chi-squared test and Fisher’s exact test compared differences between categorical variables. The binary logistic regression analysis was performed to examine the influence of the variables on the choice of CSP treatment strategies. The positive predictive value and negative predictive value of risk factors were calculated using the receiver operating characteristic (ROC) curve. p-values, representing two-sided probabilities, were considered statistically significant at $p < 0.05$.

3. Results

The baseline clinical characteristics of patients undergoing different strategies for treating CSP are detailed in Table 1. The L/S+H/S group, which consisted of only one individual, was not included in the statistical analysis. Significant differences were observed in CS frequency ($p < 0.05$), GA ($p < 0.001$), GSD ($p < 0.001$), EL ($p < 0.001$), fetal heartbeat ($p = 0.001$), myometrial thickness ($p < 0.001$), CSP subtype ($p < 0.001$), pre-treatment serum $\beta$-hCG levels ($p < 0.001$), reduction in $\beta$-hCG levels post-treatment ($p < 0.001$), blood loss ($p < 0.001$), duration of hospitalization post-treatment ($p < 0.001$), and cost among the other four treatment strategies ($p < 0.001$) (Table 1).

Patients undergoing UAE, more specifically UAE+C and UAE+H/S+S, exhibited a greater reduction in post-operative serum $\beta$-hCG levels compared to patients not undergoing UAE (D&C, H/S+C, L/S+H/S), and incurred significantly higher hospitalization costs. The D&C group experienced less bleeding compared to other groups ($p < 0.05$, Table 1).

There was no significant difference in treatment success rates among the groups ($p > 0.05$, Table 1). Two patients with treatment failure were diagnosed with type II CSP. In the first case, post-operative detection of residual pregnancy tissue followed an initial D&C. A successful resolution was achieved four weeks later with a combined approach of UAE+H/S+C. The second case involved UAE+C, where intra-operative ultrasound exposed complications in
<table>
<thead>
<tr>
<th>Table 1. Demographic and clinical characteristics of the patients undergoing different treatment strategies for CSP.</th>
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<tbody>
<tr>
<td><strong>Overall (N = 220)</strong></td>
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<tr>
<td>Maternal age (years)</td>
</tr>
<tr>
<td>Previous D&amp;C</td>
</tr>
<tr>
<td>Previous CSP</td>
</tr>
<tr>
<td>Interval since the last CS (years)</td>
</tr>
<tr>
<td>GSD (cm)</td>
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<tr>
<td>EL (cm)</td>
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<tr>
<td>Fetal heartbeat n (%)</td>
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<tr>
<td>Myometrial thickness (mm)</td>
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<tr>
<td>Subtype n (%)</td>
</tr>
<tr>
<td>Type I</td>
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<tr>
<td>Type II</td>
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<tr>
<td>Type III</td>
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<tr>
<td>Pre-treatment serum β-hCG (mIU/mL)</td>
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<tr>
<td>Reduction in β-hCG levels post-treatment (%)</td>
</tr>
<tr>
<td>Cost (Yuan Renminbi)</td>
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<tr>
<td>Success rate (%)</td>
</tr>
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</table>

Normally distributed continuous variables: mean ± standard deviation (SD), non-normally distributed continuous variables: median [min–max], categorical variables: n (%). *: one-way analysis of variance (ANOVA) test; **: Kruskal-Wallis test; ***: Pearson Chi-Square/Fisher’s Exact test. CSP, cesarean scar pregnancy; D&C, dilation and curettage; UAE+C, curettage after uterine artery embolization; H/S+C, hysteroscopy plus curettage; UAE+H/S+C, H/S+C following UAE; L/S+H/S, hysteroscopy combined with laparoscopic resection; CS, cesarean section; GA, gestational age; GSD, gestational sac diameter; EL, embryonic length; β-hCG, serum β-human chorionic gonadotropin. 1 Yuan Renminbi ≈ 0.1382 USDollars (USD).
removing residual placental tissue due to thinning of the anterior isthmic wall and placental implantation. Significant active bleeding ensued, not controlled by intramuscular carboplatin or compression with iodine-soaked gauze, leading to 1500 ml of blood loss. The patient required a transfusion of 1.5 units of red blood cells and 400 mL of plasma. Subsequently, a procedure was performed to remove the CSP lesion and re-suture the uterus.

This study employed binary logistic regression to assess the relationship between GA, pre-treatment serum \( \beta \)-hCG levels, GSD, EL, and myometrial thickness in relation to UAE. Among the five variables included, GSD (odds ratio (OR): 1.651, 95% confidence interval (95% CI): 1.041–2.616, \( p = 0.033 \)) and myometrial thickness (OR: 0.295, 95% CI: 0.175–0.499, \( p < 0.001 \)) were found to be statistically significant (Table 2). The area under the ROC curve (AUC) for the GSD was 0.856, with a standard error of 0.026, and its 95% CI ranged from 0.804 to 0.908. The cut-off value was 3.05 cm, corresponding to a sensitivity of 81.5% and a specificity of 76.0% (Fig. 2). The AUC for the myometrial thickness was 0.814, with a standard error of 0.032, and its 95% CI ranged from 0.751 to 0.878. The cut-off value was 1.55 mm, corresponding to a sensitivity of 83.8% and a specificity of 67.7% (Fig. 3).

The Pearson Chi-square test and Fisher’s exact test were used to assess the association of fetal heartbeat and CSP subtype with UAE. Both variables were significantly related to UAE, with \( p < 0.005 \) (Table 3).

The relationship of GA, pre-treatment serum \( \beta \)-hCG levels, GSD, EL, and myometrial thickness on surgical approach was evaluated using binary logistic regression. Among the five variables included, myometrial thickness demonstrated statistical significance (OR: 0.412, 95% CI: 0.291–0.581, \( p < 0.001 \)) (Table 2). The AUC for the myometrial thickness was 0.748, with a standard error of 0.032, and its 95% CI ranged from 0.684 to 0.811. The cut-off value was 1.65 mm, corresponding to a sensitivity of 80.7% and a specificity of 57.0% (Fig. 4).

The association of fetal heartbeat and CSP subtype with the surgical approach was evaluated using the Pearson Chi-Square test and Fisher’s exact test. Among the two variables included, fetal heartbeat was not associated (\( p = 0.898 \)), whereas CSP subtype was significantly associated with the surgical approach (\( p < 0.001 \)) (Table 3).

4. Discussion

As the rate of CS increases and ultrasound diagnostic techniques advance [10], CSP has become increasingly common. To date, there is no unified standard for the treatment of CSP, both domestically and internationally. Treatment plans are primarily dependent on the expertise and judgment of specialist physicians [4], whereby the professional proficiency and depth of disease understanding of the attending physician significantly influence the treatment outcomes.

The primary treatment methods for CSP include local and/or systemic administration of MTX [11]. UAE combined with MTX infuson chemotherapy, D&C, hysteroscopic lesion removal, as well as laparoscopic, abdominal, or transvaginal lesion removal [4]. Each of these diagnostic and therapeutic approaches present its own set of advantages and disadvantages.

The efficacy of MTX treatment is limited and depends upon the patient’s hemodynamic stability. Studies [10,12,13] suggest that initiating treatment early and encountering lower initial serum \( \beta \)-hCG levels are associated with a higher success rate. However, no consensus exists regarding the specific \( \beta \)-hCG levels and GSD thresholds for predicting the success of MTX therapy [14,15]. UAE combined with MTX offers a less invasive option for clinically stable CSP patients, but may lead to delayed \( \beta \)-hCG recovery and potential liver function damage [16–20]. Additionally, drawbacks of MTX treatment encompass prolonged hospitalization and higher risks of bleeding and uterine rupture [21]. Considering the limitations associated with medical treatment [22], our medical institution generally favors surgical interventions.

UAE stands out as the most effective and rapid treatment for controlling bleeding [18]. Nevertheless, it is associated with high costs and post-operative complications [23], including spasmodic pain, fever (post-embolization...
Table 2. Logistic regression analysis for factors related to UAE and D&C.

<table>
<thead>
<tr>
<th>Factor</th>
<th>UAE OR (95% CI)</th>
<th>p-value</th>
<th>D&amp;C OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA (days)</td>
<td>1.029 (0.987–1.073)</td>
<td>0.173</td>
<td>1.011 (0.979–1.044)</td>
<td>0.494</td>
</tr>
<tr>
<td>Pre-treatment serum β-hCG (mIU/mL)</td>
<td>1.000 (1.000–1.000)</td>
<td>0.164</td>
<td>1.000 (1.000–1.000)</td>
<td>0.773</td>
</tr>
<tr>
<td>GSD (cm)</td>
<td>1.651 (1.041–2.616)</td>
<td>0.033</td>
<td>1.142 (0.839–1.556)</td>
<td>0.398</td>
</tr>
<tr>
<td>EL (cm)</td>
<td>1.871 (0.861–4.065)</td>
<td>0.114</td>
<td>0.990 (0.556–1.760)</td>
<td>0.972</td>
</tr>
<tr>
<td>Myometrial thickness (mm)</td>
<td>0.295 (0.175–0.499)</td>
<td>&lt;0.001</td>
<td>0.412 (0.291–0.581)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

GA, gestational age; UAE, uterine artery embolization; D&C, dilation and curettage; OR, odds ratio; 95% CI, 95% confidence interval; β-hCG, serum β-human chorionic gonadotropin; GSD, gestational sac diameter; EL, embryonic length.

Table 3. The impact of fetal heartbeat and CSP subtypes on treatment strategy selection.

<table>
<thead>
<tr>
<th>Fetal heartbeat</th>
<th>UAE</th>
<th>None-UAE</th>
<th>p-value</th>
<th>D&amp;C</th>
<th>H/S+C</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>40</td>
<td>25</td>
<td>&lt;0.001</td>
<td>51</td>
<td>42</td>
<td>0.898</td>
</tr>
<tr>
<td>N</td>
<td>53</td>
<td>101</td>
<td></td>
<td>68</td>
<td>58</td>
<td></td>
</tr>
</tbody>
</table>

Subtype n

| Type I          | 3   | 40       | <0.001  | 38  | 5     |         |
| Type II         | 40  | 97       |         | 71  | 66    | <0.001  |
| Type III        | 22  | 17       |         | 10  | 29    |         |

CSP, cesarean scar pregnancy; UAE, uterine artery embolization; D&C, dilation and curettage; H/S+C, hysteroscopy plus curettage.

Fig. 3. ROC curves for evaluating the effectiveness of myometrial thickness in predicting none-UAE. The AUC for the myometrial thickness was 0.814, with a standard error of 0.032, and its 95% CI ranged from 0.751 to 0.878. The cut-off value was 1.55 mm, corresponding to a sensitivity of 83.8% and a specificity of 67.7%. AUC, area under the ROC curve; 95% CI, 95% confidence interval; ROC, receiver operating characteristic; UAE, uterine artery embolization.

Fig. 4. ROC curves for evaluating the effectiveness of myometrial thickness in predicting D&C. The AUC for the myometrial thickness was 0.748, with a standard error of 0.032, and its 95% CI ranged from 0.684 to 0.811. The cut-off value was 1.65 mm, corresponding to a sensitivity of 80.7% and a specificity of 57.0%. AUC, area under the ROC curve; 95% CI, 95% confidence interval; ROC, receiver operating characteristic; D&C, dilation and curettage.
syndrome), ovarian failure, uterine-rectal fistulas, uterine-bladder fistulas, and uterine necrosis. These complications have been reported to potentially affect the outcomes of subsequent pregnancies [18,24]. Previous studies have indicated that adjunctive UAE may not be necessary for all CSP patients [25,26], and therefore, it should be carefully considered. A meta-analysis of 3101 patients with CSP found that larger GSD, advanced GA, higher serum β-hCG levels, and abundant blood flow around the lesion are risk factors for significant bleeding [27]. The study by De Braud et al. [28] indicated that in cases involving a viable fetus, the risk of severe bleeding during surgery increases with GA, particularly in the presence of placental lakes. In women with a GA of ≥9 weeks (crown-rump length ≥23 mm), one-third required blood transfusions [28]. However, in our study, GA and EL were not significantly associated with the need for UAE. The logistic regression analysis in this study identified larger GSD and thinner myometrial thickness as risk factors for requiring UAE. In addition, fetal heartbeat and CSP subtypes are also associated with the need for UAE. Our study shows that the likelihood of requiring UAE increases when GSD exceeds 3.05 cm and myometrial thickness is less than 1.55 mm. This inconsistency may arise from certain CSP patients in the study experiencing halted embryonic development, where the enlargement of the GS size did not align with embryonic development and serum β-hCG levels. Our findings also suggest that CSP subtypes are associated with UAE. Considering the high correlation between the Chinese classification of CSP and myometrial thickness, a combined analysis of myometrium thickness and CSP subtypes concluded that type I CSP is less likely to require UAE, which is consistent with findings from prior literature [9]. In our study, the presence of a fetal heartbeat emerged as a risk factor for UAE treatment. However, in our study, the majority of type I CSP patients (13/15) with a fetal heartbeat did not undergo UAE treatment in our study and still achieved successful outcomes. Therefore, our study has not yet reach a conclusion regarding whether GSD, myometrial thickness, or fetal heartbeat is the more critical risk factor for UAE.

In our study, there was no significant difference in the success rates between D&C and H/S+C. D&C stands as the simplest and least invasive surgical method. However, its non-selective and blind uterine evacuation may potentially result in uncontrolled massive bleeding or uterine rupture, thereby posing a risk of uterine resection [29]. Various studies recommend varied criteria for determining the suitability of D&C, and as of yet, there is no unified standard [26,30,31]. In contrast to D&C, hysteroscopy provides direct visualization of the uterine cavity, enabling a clear diagnosis and thorough removal of pregnancy tissue from the cesarean scar site [3,32,33].

Our study found that when myometrial thickness was less than 1.65 mm, H/S+C was more likely to be chosen. This finding differs from previous studies [34], which considered hysteroscopy a better choice for women with a myometrial thickness >3 mm. Thinner myometrial thickness is often associated with deep cesarean scar diverticulum (CSD), and the deeper the CSD, the more challenging it becomes for D&C due to the lack of direct visualization, leading to a higher risk of initial treatment failure. Even in cases where the myometrial thickness is extremely thin, careful operation can mitigate the risk of uterine perforation, as this thin layer is closely attached to the posterior wall of the bladder. In our study, no cases of uterine perforation or organ trauma occurred.

Compared to D&C, hysteroscopy reduces the chances of initial treatment failure. However, hysteroscopy significantly increases the cost of treatment, and thus is not recommended for all types of CSP patients. Consistent with this study, another retrospective study conducted by our medical institution also showed that there is no difference in the failure rate of CSP treatment between ultrasound-guided D&C and hysteroscopy, regardless of whether UAE is performed [26].

In our study, a type III CSP patient underwent L/S+H/S, a comprehensive approach that excises the CSP lesion and simultaneously repairs the original uterine scar defect. This method is considered the preferred and optimal approach for cases of conservative treatment failure, uterine rupture, or suspected uterine rupture [35]. While UAE combined with surgical excision exhibits more favorable outcomes compared to other treatments regarding the duration of vaginal bleeding, abnormal serum β-hCG levels, and the presence of abnormal pregnancy masses [36], concerns persist regarding the significant trauma associated with CSP lesion excision surgery, the relatively prolonged post-operative recovery period, and the ongoing debate surrounding the improvement of subsequent pregnancy outcomes by uterine scar repair surgery [37,38]. Therefore, excision of the CSP lesion should not be considered the first-line treatment method [37].

The strengths of this study primarily lie in its large sample size and rigorous research design, which encompassed well-defined inclusion and exclusion criteria, detailed treatment procedures, and comprehensive follow-up. However, due to the retrospective nature of the study, the treatment approach was non-randomized and primarily based on expert opinion. Therefore, to provide a nuanced analysis, patients were divided into subgroups, allowing for a separate examination of the risk factors associated with each treatment strategy. The limitations of the study stem from its retrospective cohort nature, wherein the allocation of patients was subject to many constraints, precluding strict randomization. Although initial risk factors might influence the decision on treatment strategy, the final treatment plan was chosen based on expert opinion. Moreover, the study focused solely on severe complications, leading to the omission of recording some relatively minor post-operative complications. Lastly, as a gyneco-
logical teaching and treatment center, the surgeons’ operative experience and diagnostic expertise were superior, which likely contributed to better diagnostic and surgical outcomes. However, this study’s failure to consider the surgeons’ experience as a potential risk factor represents a missed opportunity to explore its impact on outcomes. Therefore, future research will be designed with more rigorous methodologies to reduce allocation bias.

5. Conclusions

Overall, this study demonstrated that there is no significant difference in the success rate for treating CSP between D&C and H/S+C alone, or in combination with UAE. However, the incorporation of UAE or H/S+C into the treatment regimen significantly increases both the cost of treatment and the duration of hospital stay. Factors such as a larger GSD, reduced myometrial thickness, the presence of a fetal heartbeat, and a higher CSP subtype were identified as risk factors for choosing UAE, while a reduced myometrial thickness and a higher CSP subtype were identified as risk factors for opting for H/S+C. For different patients, it is essential to carefully select the treatment option based on the relevant risk factors.

Availability of Data and Materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request with the permission of the Ethics Committee of the Women’s Hospital, School of Medicine, Zhejiang University.

Author Contributions

XN and YZ conceived and designed the study. SN, JY and SL collected the data. XN and JY analyzed the data. XN and SN wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors have read and approved the final manuscript.

Ethics Approval and Consent to Participate

Given Considering the nature of the retrospective approach and the anonymization of patient data, approval (IRB-20220061-R) for the study protocol has been granted by the Ethics Committee of Women’s Hospital, School of Medicine, Zhejiang University. Consequently, the necessity of obtaining informed consent from individual patients has been waived. This exemption is due to the low risk posed to participants by the retrospective analysis of anonymized data, which ensures that patient confidentiality and privacy are maintained.

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Conflict of Interest

The authors declare no conflict of interest.

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