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Indian Journal of Obstetrics and Gynecology Research

Journal homepage: www.ijogr.org

Review Article

Uterine artery embolization: A novel frontier in the treatment of caesarean scar pregnancy

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Abstract

This study aims to analyse the outcome of UAE treatment in CSP population to calculate the overall success rate. Caesarean scar pregnancy (CSP) is an infrequent ectopic pregnancy now more frequently associated with increasing rates of caesarean section, which are associated with significant morbidity, such as haemorrhage and uterine rupture. Early ultrasound diagnosis is critical for treatment, whereas uterine artery embolization (UAE) has been effective in managing CSP recurrences and prevented serious complications.

A comprehensive search across PubMed, Google Scholar and Scopus yielded 4844 records out of which 9 studies were finally selected of which 8 studies were selected for meta analyses. SPSS version 28 and R Studio were used for data analysis and graph preparation respectively. The overall success rate was 94.61% in a total of 3688 UAE treated CSP patients. UAE proved to be effective with promising success rates.

Keywords: Caesarean scar pregnancy, Uterine artery embolization, success rate, Systematic review, Meta-analyses.

Received: 27-01-2025; **Accepted:** 02-05-2025; **Available Online**: 13-08-2025

1. Introduction

Caesarean scar pregnancy is a rare ectopic pregnancy and the incidence is a rare ectopic pregnancy and the incidence is progressively increasing now a days due to increase in the incidence of caesarean delivery.[1] Caesarean scar pregnancy is due to a defect in the healing process of the previous caesarean section. The increase in mortality due to this diagnosis and lack of knowledge regarding the management strategy. In this conditions, early diagnosis is the main stage of management.[2] The knowledge regarding the types of placenta accrete spectrum associated with caesarean scar pregnancy is a major negative factor for successful outcome.[3] The major factors leading to morbidity are massive haemorrhage, uterine rupture leading to hysterectomy, especially in early trimester.

The early diagnostic factor in CSP are detection of the placenta and gestational sac in scar of the uterus (previous surgery), a thin <3mm myometrium lay between the bladder and the gestational sac sometimes maybe adjacent and the gestational sac occupying the niche of the scar initially arterial doppler may show increased vascularity around the chorionic sac and placenta. In the early trimester the uterus is empty and the gestational sac / foetal not may be observed in the yolk sac. In the dehiscence of the previous scar. The ultrasound examination done in the early first trimester helps in decision-making and to rule out (placenta accrete spectrum) PAS.

The new classification of CSP has 3 types according to the location of the sac. The exact location of the gestational sac and the PAS decide the fate of the pregnancy whether to terminate or continue. Although most of CSP are terminated some may have a progressive intrauterine pregnancy resulted in live birth.[4]

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https://doi.org/10.18231/j.ijogr.v.12.i.3.2

CSP is an ectopic pregnancy located in the scar of the previous caesarean section.[5] Sometimes there is a recurrence in the incidence of CSP. The risk factor there is due to a defect in the myometrium featuring a previous scar in the uterus due to scar dehiscence. There are multiple risk factors for CSP like curettage, myomectomy, manual removal of placenta and in vitro fertilization.[6] CSP can occur in the lower segment of the uterus due to defect in developmental anomaly.[7]

Transvaginal ultrasound is the diagnostic investigation to pick up the condition early.[8] It is very significant to diagnose an early pregnancy to avoid complications like uterine rupture, which can lead to severe haemorrhage and hysterectomy especially associated with the placenta accrete spectrum. Three-dimensional (3D) ultrasound and color doppler are the gold standard for CSP diagnosis.[9]

Uterine artery embolization (UAE) especially is one of the best methods for the treatment of CSP. It can be done alone or with other procedures in the treatment of CSP. It saves the life and avoids massive blood loss.[10] We aimed to analyse various studies and report the overall success rate for UAE in CSP treatment in our study to depict the final outcome.

2. Materials and Methods

This systematic review and meta-analyses followed the preferred reporting item for systematic review and meta-analyses (PRISMA) guidelines (**Figure 1**).[11] The risk of bias was analysed.

2.1. Literature search

A comprehensive literature search was done to find out studies published between 2015 to 2024 on the prevalence of hypertension, its risk factors, and preventive measures. Electronic database search was done in PubMed, Google Scholar and Scopus using the keywords “Caesarean scar pregnancy”, “Uterine artery embolization” and “Success rate”.

2.2. Inclusion and exclusion criteria

The inclusion criteria were: 1.) Cases available with complete data for CSP treated with UAE 2.) Published in English.

The exclusion criteria were: - 1.) Case report 2.) Not published in English.

2.3. Data extraction

The eligibility of the article based on criteria search was completed by 2 authors (J.H. and J.K.) and the full text of the studies was analysed by using Microsoft Excel 2016. The two authors assessed the methodology and the quality of the articles by using the New Castle Ottawa assessment scale.[12] Finally, a total of 9 studies met the quality of assessment. The first author name, year, country of study, study design, sample size for UAE treated patients and success (%) were tabulated (**Table 1**). The forest graph was plotted for eight authors (**Figure 2**).

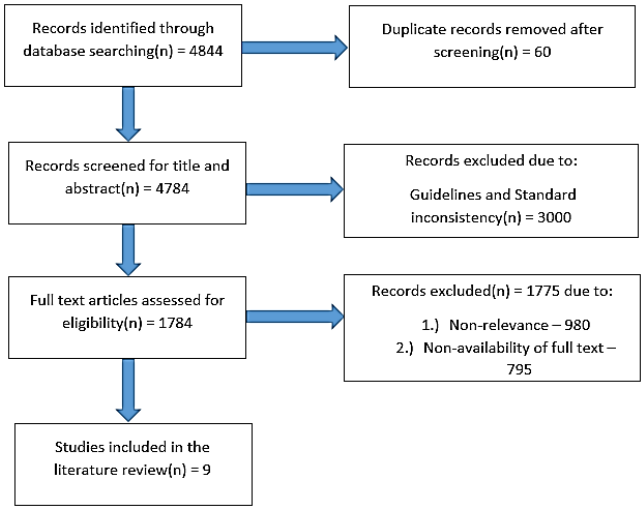

Figure 1: Flowchart for systematic review and meta analyses on treatment of CSP with UAE

2.4. Statistical analysis

SPSS version 28 was used for data analysis and R Studio for plotting graphs.

3. Results

3.1. Screening flow

According to the search strategy set in advance, a total of 4844 articles were retrieved in the target database (Figure 1). Then 60 duplicate articles were removed. Out of the remaining 4784 articles, 3000 articles were excluded during title and abstract screening (**Figure 1**). During the full text screening, a total of 1775 articles were excluded from 1784 articles. Finally, a total of 9 articles with 3688 subjects were studied.

3.2. Funnel and Egger’s test

To assess the risk of publication bias, funnel plot analysis, and Egger’s test were conducted.[13] The funnel plot showed asymmetry indicating publication bias (**Figure 3**). The Egger’s test showed a p-value of 0.351 indicating publication bias.

Meta-analysis of studies on UAE treatment for CSP revealed extremely significant heterogeneity ($p<0.001$, I^2 = 87.334%). The pooled prevalence was noted as 0.95 (95%CI: 0.93, 0.97).

3.3. Meta regression analysis

A linear regression was performed to calculate the slope, the intercept, the R-squared value, and the x-intercept for the effect size and standard error (**Figure 4**).[14] An R-squared value of roughly 0.506 means that 50.6% of the variance in standard error can be attributed to effect size; the equation for that line is thus y = -0.2279 x + 0.2370. The slope is -0.2279,

which means the relationship is negative between effect size and standard error, while the x-intercept is 1.040. It is suggested that accuracy increases with the size of the effect. Thus, standard error might fall with an increase in the facade effect size; this is exactly opposite from what happens in meta-analyses. The x-intercept point at 1.04 suggests that standard error would have zero value at effect size 1.04 but such high values are impractical for real-world applications.

The overall success rate for UAE treatment for CSP patients came out to be 94.61% (**Figure 5**). It should be mentioned that among the studies in this review, a 100% success rate was observed in a pilot series of 10 patients, as presented by an author, Pecorino.[23]

This result reveals that the UAE may be an extremely effective curative therapy for CSP in well-selected cases, especially where traditional methods are more risky, and is consistent with the typically high success rates reported in the studies reviewed.

Table 1: Study characteristics

Author	Year	Place of Study	Study Design	Sample	Success (%)
Min-hui Guo et al[15]	2015	China	Case Series	50	84
Chen Z Y et al[16]	2017	China	Retrospective	67	94
Jun-Rong WANG et al[17]	2018	China	Retrospective	47	97.24
Shanshan Cao et al[18]	2021	China	Retrospective	53	98.11
Liping Yu et al[19]	2021	China	Prospective study	61	96.72
Greg J. Marchand et al[20]	2022	USA	A Systematic Review and Meta-Analysis	2655	93.4
Xi Wang et al[21]	2023	China	Retrospective cohort study	118	92.4
Ziwei Du et al[22]	2023	China	A systematic review and meta-analysis	627	95.69
Basilio Pecorino et al[23]	2024	Italy	Retrospective	10	100

Table 2: Important findings, strengths and demerits of various studies

Author	Year	Important Findings	Merits	Gaps
Min-hui Guo et al[15]	2015	78 patients were analysed diagnosed with CSP and treated with different methods following UAE. The success rate of UAE was noted as 84%.	It gave a vivid method for early diagnosis along with several treatment strategies for CSP.	Lacks control group for comparison
Chen Z Y et al[16]	2017	Type-II CSP patients in the first trimester with a diameter less than or equal to 30 mm and gestation age less than 7 weeks were treated with hysteroscopic surgery. The role of UAE was unclear	Robust data	Retrospective nature limits generalizability
Jun-Rong WANG et al[17]	2018	In the treatment of CSP, it was noted that the blood loss was less and the treatment was successful when UAE and hysteroscopy were used.	Reported the synergy of UAE and hysteroscopy and suggested it as best treatment option.	there may be bias due to retrospective nature of study
Shanshan Cao et al[18]	2021	Uterine artery embolization combined with curettage and transvaginal repair after the CSP treatment depicted decreased complication rate of 8.82% vs 30.19% and greater success.	The novel method of trans-vaginal removal and repair was emphasized on in the treatment of CSP.	Limited sample size
Liping Yu et al[19]	2021	The time interval between the UAE and D&C for treatment of CSP was found to have faster recovery when D&C was done within 12 hrs	It was a rare kind of prospective study.	Limited sample size
Greg J. Marchand et al[20]	2022	The complication rate after UAE was 1.2% while the success rate was 93.4%	Supported the efficiency of UAE	The study included data from China mainly, so it could not be generalized.

Table 2 Continued…				
Xi Wang et al[21]	2023	In the treatment of CSP, while comparing UAE and HIFU after D&C, HIFU showed promising results.	HIFU efficacy and effectiveness in the treatment of CSP over UAE was established.	A large-scale, randomized controlled trial design is absent from the study.
Ziwei Du et a[l22]	2023	Ultrasound-guided local lauromacrogol injection(USG-LLI) had better outcome when compared to UAE in the treatment of CSP	The advantage of USH-LLI over UAE was demonstrated.	Limited number of studies
Basilio Pecorino et al[23]	2024	The success rate of UAE and D&C was 100% in contrast to methotrexate injection (44%).	UAE with D&C was showed as the best treatment for effective outcomes.	small sample size

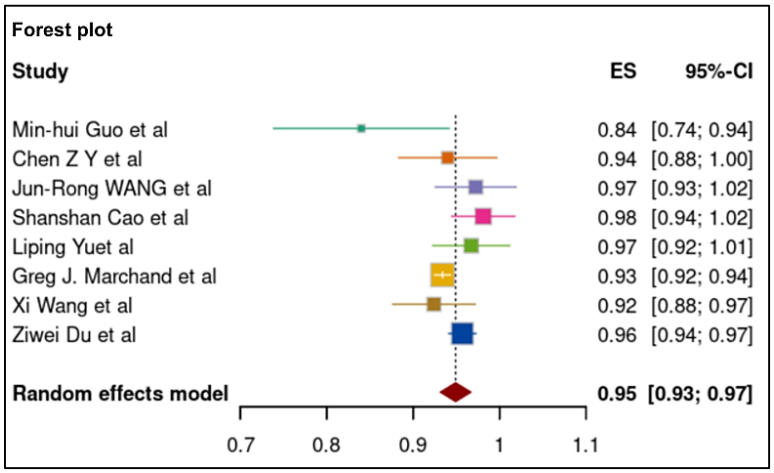

Figure 2: Forest plot for systematic review and meta analyses on UAE treatment for CSP

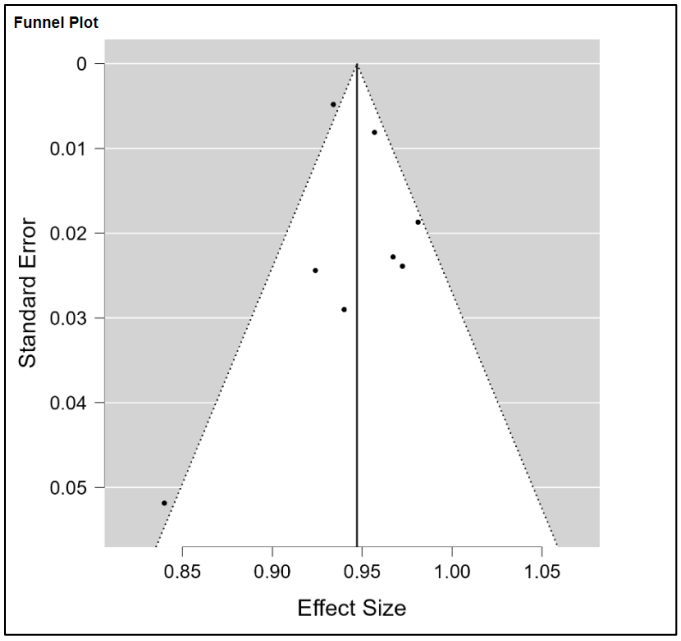

Figure 3: Funnel plot

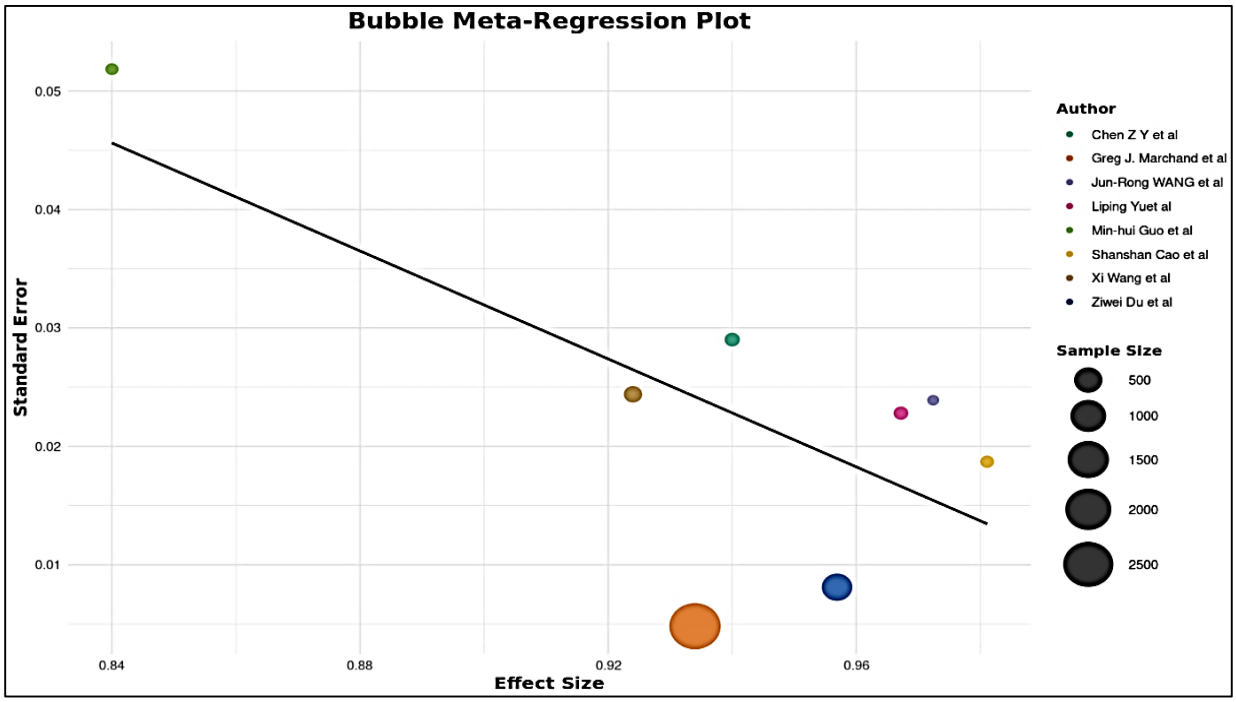

Figure 4: Bubble meta regression analysis plot

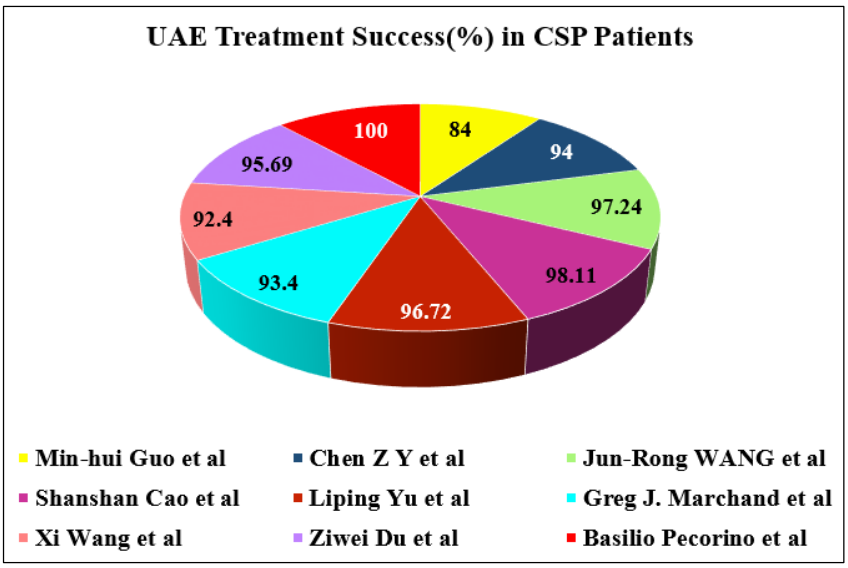

Figure 5: Success rate of UAE treatment in CSP population

4. Discussion

The management of caesarean scar pregnancy (CSP) through uterine artery embolization (UAE) was well documented, with significant findings on its efficacy and safety coming to light. The assertion by an author stated that 84% of the patients were successfully treated in a case series of 50 patients, encompassing the significance of early diagnosis: 52.56% of patients presented with intermittent vaginal bleeding, while 16,000 U/L was the average β-hCG level at diagnosis.[15] Hinging on this evidence, another author indicated the better success rate of 94% among 67 patients with significant decrease β-hCG in 72-96 hours, also noting that 63% experienced a significant decrease in β-hCG levels within 7 days post-UAE.[16] This was further corroborated by another author.[24] Yet another author supported these results with a high success rate of 97.24% in 47 cases. He stated that he had an average blood loss of 27.42 mL per case during his procedure, and 94% of patients achieved normal β-hCG levels within 30 days-suggesting the trend of rapid recovery as well.[17] Consistent with these results, another author reported the result as 98.11% in 53 patients treated with UAE, stating that in addition to curettage there was significant increase in after-hospitalization-day reductions along with an average 28-day conventional normalization time for β-Hcg.[18] Another author happily announced the success rate of 96.72% in 61 patients with a strong control of bleeding with less blood loss, in the middle of process, approximately 20 mL,

further arguing for lowering incidences of complications improving efficiency throughout the embolization process which was identified by all preceding studies.[19] This was further showed by an author.[25] Another author collected data from 2655 patients and determined that success was 93.4% on average, suggesting that the rate of 41.9mL of blood loss was observed in all UAE-combined studies, a little more than some of the primary reports, but a reflection of a largely safe profile for this group.[20] With a success rate of 92.4% for 118 patients, yet another author found a mean blood loss of 34.33 mL, with the mean time to β-hCG normalization being 30.98 days, thus winning an argument with respect to UAE's efficacy in dealing with CSP. [21] Another author managed to perform another systematic review and meta-analysis on 627 patients from a considerable number of studies documenting a 95.69% success rate through UAE, with hospitalization lasting five days on average, longer than the average of other studies but still within acceptable limits.[22] Ultimately, an author of our study pointed out a high success rate of 100% in a pilot series of 10 patients, suggesting that UAE could be a curative treatment for these cases in which conventional techniques are also riskier.[23] This is further supported by another study.[26] Together, the current researches point out the high success rates, low complications overall high efficacy of UAE as a treatment modality of CSP with a particular relevance for women who want to maintain their fertility.

5. Conclusion

Our review included maximum studies from China which is a densely populated nation like India. The aim of our study was to analyse the significant role of UAE and its success rate in the treatment of CSP. Further efforts should be made in a country like ours with a population pattern similar to China where the caesarean rates are high and the incidences of CSP are equally high to induce training, infrastructure and skills for implementing this procedure to observe better outcomes. Additionally, future research in this field would be extremely useful. Our study seeks to enkindle the enthusiasm in the young researchers to conduct further longitudinal studies in the future to come up with brilliant and promising results along with artificial intelligence tools to improve accuracy in early diagnosis and treatment.

6. Strengths and Limitations

The major strength of our study was that it spanned over a time period of 10 years. We also conducted a detailed review on UAE treatment for CSP population. However, high heterogeneity was noted attributed to the chronological factor. Moreover, majority of the studies included in our review were retrospective in nature.

7. Source of Funding

This research was not supported by any specific grants from public, commercial, or non-profit funding agencies.

8. Conflicts of Interests

The authors report no conflict of interest.

9. Author Contributions

Conceptualization and methodology, J.K., and J.H..; Formal analysis, J.K., and J.H.; Visualization and writing – original draft J.K., J.H.; Writing – review and editing, J.K., and J.H. All authors have read and agreed to the final version of the manuscript.

10. Ethical Approval

Not Required.

11. Acknowledgments

Sincere gratitude is expressed to the Head of the Department for involvement and Miss. Swathi for her technical assistance with IT, data analysis and illustration preparation.

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Cite this article: Chellamuthu J, Meignanamoorthy G, Hameed J. Uterine artery embolization: A novel frontier in the treatment of caesarean scar pregnancy. *Indian J Obstet Gynecol Res*. 2025;12(3):362–368.