(International Print/Online Journal)

SJIF IMPACT FACTOR: 6.829
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 9, Issue 2 , Page No: 120-126
March-April 2026

IJMSCR

Oxytocin versus Carbetocin for Prevention of Postpartum Hemorrhage after Cesarean Delivery: A Prospective Randomized Study from Arunachal Pradesh, India

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Type of Publication: Original Research Paper
Conflicts of Interest: Nil

Abstract

Background: Postpartum hemorrhage remains a leading contributor to maternal morbidity following cesarean delivery. Oxytocin is routinely used for prevention; however, its short duration of action necessitates continuous infusion. Carbetocin, a long-acting oxytocin analogue, may provide sustained uterine contraction with improved hemodynamic stability.

Methods: This prospective randomized controlled study included 100 parturient undergoing lower segment cesarean section under spinal anaesthesia. Participants were randomized to receive either oxytocin infusion (Group O) or single-dose intravenous carbetocin 100 µg (Group C) following delivery. Primary outcome was intraoperative blood loss. Secondary outcomes included uterine tone, requirement of additional uterotonics, hemodynamic changes, and adverse effects.

Results: Mean blood loss was significantly lower in the carbetocin group compared with oxytocin (540 ± 100 mL vs 720 ± 120 mL; $p<0.001$). Adequate uterine tone was achieved more frequently with carbetocin (94% vs 76%, $p=0.01$), and fewer patients required additional uterotonics (12% vs 40%, $p<0.001$). Oxytocin administration was associated with greater reductions in mean arterial pressure and higher incidence of hypotension ($p<0.05$). Adverse effects were otherwise comparable between groups.

Conclusion: Carbetocin may provides superior uterine contractility with reduced blood loss and decreased requirement for additional uterotonics compared with oxytocin following cesarean section, supporting its role as an effective alternative for prevention of postpartum hemorrhage.

Keywords: Carbetocin, Oxytocin, Cesarean section, Postpartum hemorrhage, Spinal anesthesia.

Introduction

Postpartum hemorrhage (PPH) remains one of the leading causes of maternal morbidity and mortality worldwide, accounting for nearly one-quarter of maternal deaths globally, particularly in low- and middle-income countries. Preventive strategies must be established as essential elements of obstetric healthcare delivery. Uterine atony represents the primary reason for PPH which especially occurs after cesarean delivery because surgical and anesthetic elements combine to heighten bleeding risks. The third stage of labor needs to be managed actively through uterotonic medication since this approach protects mothers from excessive blood loss while safeguarding their health [1].

Oxytocin serves as the primary recommended uterotonic drug for PPH prevention because it has demonstrated both effectiveness and safety. The drug requires continuous infusion or multiple doses because its plasma half-life lasts only 3 to 5 minutes, which results in dangerous fluctuations of uterine contractility and blood pressure instability [2]. Oxytocin delivery through fast intravenous methods has resulted in both low blood pressure and high heart rates while causing stress to the myocardium, especially when patients received spinal anesthesia during cesarean sections [3].

Scientists developed carbetocin as a synthetic long-lasting oxytocin alternative to overcome existing limitations. The drug achieves prolonged uterotonic effects through its structural modification which protects it from being broken down by enzymes after a single intravenous administration. The continuous effect creates persistent uterine contractions which reduce the requirement for extra uterotonic medications. Landmark trials and meta-analyses have demonstrated that carbetocin is at least as effective as oxytocin in preventing PPH, with potential advantages in maintaining uterine tone and simplifying drug administration [4, 5].

The randomized controlled trials which studied carbetocin and oxytocin as treatments for cesarean delivery found that carbetocin administration resulted in lower blood loss and better uterine contractions and reduced need for additional uterotonics [6-9]. The meta-analyses back these findings because they show that hemostatic effectiveness improved without causing more adverse maternal effects to occur [1, 10]. The evidence base is expanding yet regional population data remains scarce because clinical practices and patient characteristics show differences.

This study aims to evaluate how effective oxytocin and carbetocin are for preventing postpartum hemorrhage which occurs after lower segment cesarean section (LSCS) in Aruanchal Pradesh tribal parturient while focusing on intraoperative blood loss and uterine tone and hemodynamic stability and the need for additional uterotonic treatment.

Materials and methods

Study Design and Setting: This prospective randomized controlled study was conducted in the tertiary care centre, from February 2025 to February 2026. The Institutional Ethical Committee approval was obtained before starting the research and written informed consent was also obtained from all patients who took part in the study.

Patient Selection: The study included 100 pregnant women who had singleton and needed a c-section because of medical reasons or emergency situations and required spinal anesthesia for their lower segment cesarean section**.** Only patients belonging to American Society of Anesthesiologists (ASA) physical status II with term pregnancy (≥37 weeks of gestation) were included. The study excluded patients who had placenta previa or placenta accreta and who had coagulation disorders or pregnancy-induced hypertension or eclampsia or who had known cardiac disease or multiple pregnancies.

Randomization: Eligible patients were randomly assigned into two groups using a computer-generated randomization sequence. Allocation concealment was maintained until administration of the study drug.

Anaesthesia Technique: All patients received spinal anaesthesia under standard aseptic precautions in the operating theatre. Following intravenous access and preloading with crystalloid solution, subarachnoid block was performed in the left lateral position at the L3–L4 or L4–L5 intervertebral space using a 25-gauge spinal needle. A standardized dose of 0.5% hyperbaric bupivacaine 12.5 mg with fentanyl 25 µg as an adjuvant was administered intrathecally according to institutional protocol.

After confirmation of adequate sensory blockade (up to T4–T6 dermatome level), surgery was commenced. All patients received standard intraoperative monitoring, including continuous electrocardiography (ECG), non-invasive blood pressure (NIBP) measurement, pulse oximetry, and heart rate monitoring throughout the procedure. Hemodynamic parameters (heart rate and mean arterial pressure) were recorded at baseline prior to spinal anaesthesia, immediately after intrathecal drug administration, at 5-minute intervals following delivery of the baby, and thereafter every 5 minutes until the end of surgery. Hypotension (defined as a decrease in mean arterial pressure >20% from baseline) was treated with intravenous fluids and vasopressor support as required.

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Intervention: Participants were randomly allocated into two groups based on the uterotonic agent administered immediately following delivery of the baby and clamping of the umbilical cord.

Group O (Oxytocin group): Patients received 10 IU oxytocin diluted in 500 mL of Ringer's lactate administered as a controlled intravenous infusion over 4 hours for prophylaxis against postpartum hemorrhage.

Group C (Carbetocin group): Patients received 100 µg carbetocin administered as a slow intravenous bolus over approximately 1 minute immediately after delivery of the baby.

All other intraoperative management, including surgical technique and fluid administration, was standardized between groups. Additional uterotonic agents were administered when inadequate uterine contraction or excessive bleeding was noted, as judged by the attending obstetrician. Rescue uterotonics included additional oxytocin (5–10 IU) or methylergometrine 0.2 mg intramuscularly according to institutional protocol and clinical indication.

Sample Size: A total of 100 parturients were enrolled in the study and randomly allocated into two equal groups of 50 patients each. The sample size estimation was based on an expected 20% reduction in intraoperative blood loss with carbetocin compared to oxytocin, which was considered clinically relevant. The number of participants required was calculated to provide sufficient statistical power (80%) at a significance level of 5%, enabling reliable detection of differences between the study groups.

Statistical Analysis: Statistical analysis was performed using SPSS software version 23.0. Continuous variables were expressed as mean ± standard deviation. Comparisons between groups were performed using Student's t-test for continuous data and Chi-square test for categorical variables. A p-value of less than 0.05 was considered statistically significant

Results

Study Population: A total of 120 parturients were assessed for eligibility, of whom 100 patients met inclusion criteria and were randomized equally into two groups: oxytocin group (Group O, n=50) and carbetocin group (Group C, n=50). Data from 100 patients were included in the final analysis [Figure 1].

Baseline Characteristics: Both groups were comparable with respect to demographic and perioperative characteristics. There were no statistically significant differences in age, body weight, gestational age or duration of surgery between the two groups ($p>0.05$), indicating adequate randomization [Table 1].

Primary Outcome: Intraoperative Blood Loss: Mean intraoperative blood loss was significantly lower in the carbetocin group compared with the oxytocin group (540 ± 100 mL vs 720 ± 120 mL, $p<0.001$). Additionally, the decrease in postoperative hemoglobin concentration was significantly smaller in patients receiving carbetocin (1.2 ± 0.4 g/dL) compared with oxytocin (1.8 ± 0.5 g/dL) ($p<0.01$) [Table 2].

Uterine Tone and Requirement of Additional Uterotonics: Adequate uterine tone following placental delivery was achieved more frequently in the carbetocin group (94%) compared with the oxytocin group (76%), which was statistically significant ($p=0.01$). The requirement for additional uterotonic agents was significantly higher in the oxytocin group, with 40% of patients requiring rescue medication compared with only 12% in the carbetocin group ($p<0.001$). Blood transfusion requirement was lower in the carbetocin group; however, this difference did not reach statistical significance [Table 3].

Hemodynamic Parameters: Both groups maintained overall hemodynamic stability throughout the intraoperative period. However, patients receiving oxytocin demonstrated a significantly greater reduction in mean arterial pressure compared with those receiving carbetocin (18 ± 6% vs 10 ± 5%, $p<0.01$). The incidence of hypotension was significantly higher in the oxytocin group (18%) compared with the carbetocin group (8%) ($p=0.04$). Tachycardia was also more frequently observed with oxytocin administration (22% vs 10%, $p=0.03$) [Table 4].

Adverse Effects: The incidence of nausea and vomiting was comparable between the two groups and did not show statistical significance ($p=0.18$). No serious drug-related complications were observed in either group.

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Discussion

The present study examined how effective oxytocin and carbetocin worked to prevent postpartum hemorrhage in women who had cesarean deliveries. The study showed that carbetocin treatment decreased blood loss during surgery and increased uterine contraction strength while reducing the need for additional uterotonic medications when compared to standard oxytocin infusion. The results of this study support current research which shows that long-acting uterotonics provide medical benefits during cesarean sections.

Carbetocin's prolonged uterotonic action is attributed to its resistance to enzymatic degradation, allowing sustained stimulation of oxytocin receptors and maintenance of uterine contractility after a single dose [4]. This pharmacologic property minimizes the fluctuations in uterine tone frequently observed with short-acting oxytocin infusions and may explain the reduced bleeding observed in the present study. Similar findings were reported in randomized trials where carbetocin significantly decreased blood loss and need for additional uterotonics compared with oxytocin [8-9].

The improved uterine tone observed in the carbetocin group aligns with results from recent randomized and double-blind clinical trials conducted in high-risk cesarean deliveries, which demonstrated superior uterine contractility and improved surgical field conditions following carbetocin administration [6-7]. Furthermore, meta-analysis research evidence has confirmed that carbetocin reduces the incidence of PPH and requirement for supplementary uterotonic agents without increasing adverse maternal effects [1, 10].

The current research shows greater hemodynamic stability observed with carbetocin which is also supported by previous studies showing fewer cardiovascular fluctuations as compared with oxytocin. Rapid bolus administration of oxytocin is known to cause vasodilation and transient hypotension, particularly under regional anesthesia, whereas carbetocin produces a more gradual hemodynamic response [3]. These characteristics may be especially beneficial in obstetric anesthesia practice where maintenance of maternal cardiovascular stability is crucial. The findings of present study are further supported by international recommendations emphasizing effective uterotonic prophylaxis as a cornerstone of PPH prevention. WHO and FIGO guidelines advocate timely administration of uterotonics during cesarean delivery, highlighting the evolving role of longer-acting agents such as carbetocin in optimizing active management strategies [2, 11].

Overall, the finding of present study reinforce accumulating evidence that carbetocin provides effective and sustained uterine contraction, reduces pharmacologic intervention, and simplifies perioperative management during cesarean delivery. These advantages may be particularly relevant in high-volume obstetric settings where streamlined drug administration and consistent uterine tone are desirable.

Limitations:

The present study has certain limitations that should be considered while interpreting the findings. First, this was a single-center study conducted in a tertiary care centre, which may limit the generalisation of the results to other clinical settings and populations. Second, the sample size, although adequately powered to detect differences in primary outcomes, was relatively modest and may not fully capture rare adverse effects associated with uterotonic agents. Third, estimation of intraoperative blood loss included a component of visual assessment, which may introduce observer variability despite the use of standardized measurement methods. Additionally, uterine tone assessment was based on clinical palpation and therefore subject to some degree of subjective interpretation. Finally, long-term maternal outcomes and cost-effectiveness analysis were not evaluated in this study.

Conclusion

Carbetocin demonstrated superior efficacy compared with conventional oxytocin infusion in the prevention of postpartum hemorrhage following lower segment cesarean section. The treatment resulted in decreased intraoperative blood loss together with lower postoperative hemoglobin decline and better uterine contraction maintenance which reduced the need for extra uterotonic drugs. Carbetocin maintained comparable hemodynamic stability through its use which resulted in fewer adverse effects than other treatments. The single-dose administration further

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simplifies clinical management and may enhance efficiency in obstetric practice. Carbetocin therefore represents an effective alternative to oxytocin for prophylaxis of postpartum hemorrhage during cesarean delivery although larger multicenter studies are recommended to confirm these findings and evaluate cost-effectiveness.

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CONSORT Flow Diagram

Figure 1: CONSORT flow diagram showing patient enrollment, randomization, allocation, follow-up, and analysis in oxytocin and carbetocin groups following LSCS.

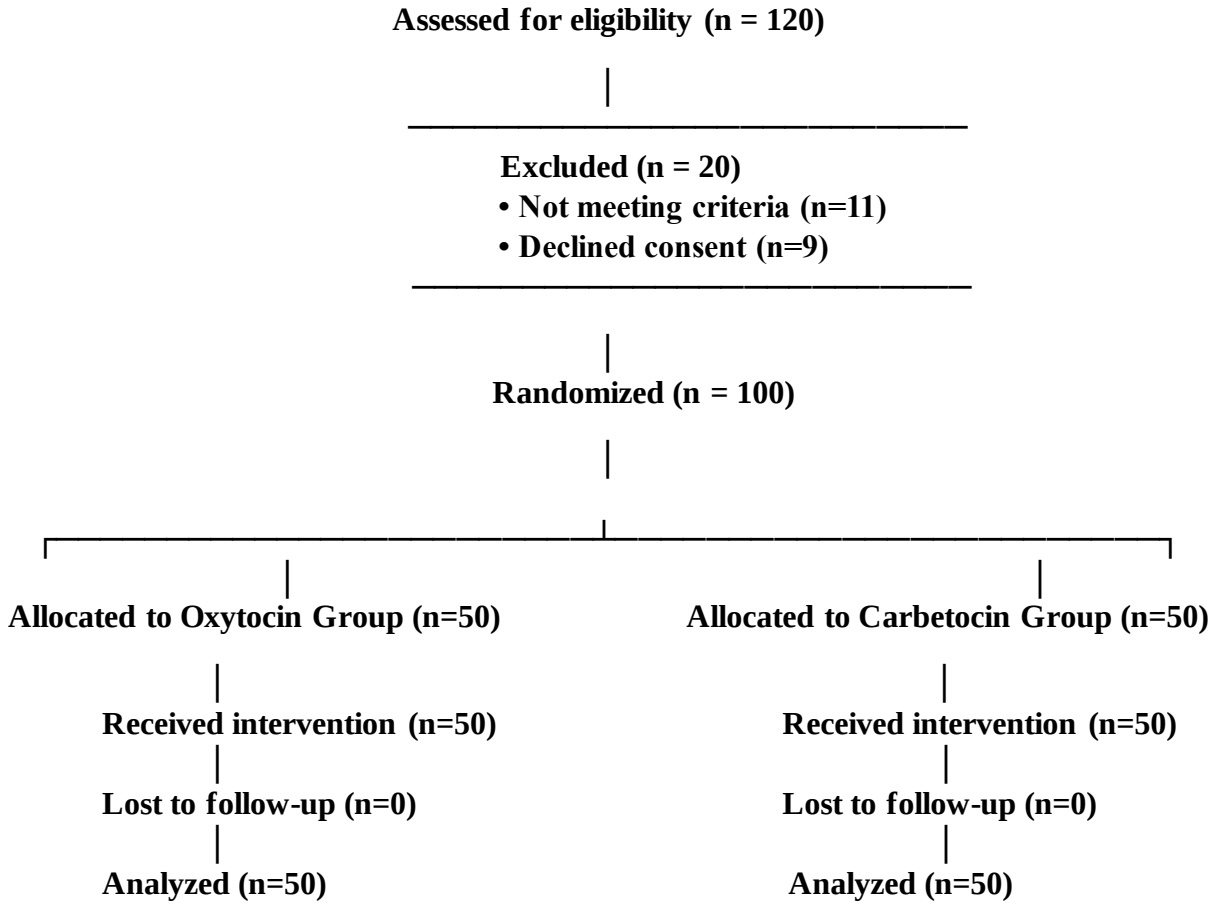

Table 1. Baseline Characteristics

Variable	Oxytocin (n=50)	Carbetocin (n=50)	p value
Age (years)	27.6 ± 4.2	26.9 ± 4.8	0.48
Weight (kg)	68.1 ± 6.9	69.3 ± 7.1	0.39
Gestational age (weeks)	38.5 ± 1.1	38.6 ± 1.0	0.71
Duration of surgery (min)	58 ± 9	57 ± 8	0.55

Data expressed as mean ± SD or number

Table 2. Primary Outcome — Blood Loss

Outcome	Oxytocin	Carbetocin	Mean Difference	p value

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Blood loss (mL)	720 ± 120	540 ± 100	180 mL	<0.001*
Hb fall (g/dL)	1.8 ± 0.5	1.2 ± 0.4	0.6	<0.01*

*Statistically significant.

Table 3. Uterine Tone and Additional Uterotonics

Parameter	Oxytocin	Carbetocin	p value
Adequate uterine tone (%)	76%	94%	0.01
Additional uterotonic required	20 (40%)	6 (12%)	<0.001*
Need for transfusion	4 (8%)	1 (2%)	0.17

*Statistically significant.

Table 4. Hemodynamic Changes & Adverse Effects

Variable	Oxytocin	Carbetocin	p value
MAP decrease (%)	18 ± 6	10 ± 5	<0.01*
Hypotension	9 (18%)	4 (8%)	0.04
Tachycardia	11 (22%)	5 (10%)	0.03
Nausea/Vomiting	10 (20%)	6 (12%)	0.18

*Statistically significant

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