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Original Research Article

Carbetocin vs Oxytocin in Caesarean Section to Prevent Post-Partum Hemorrhage – A Randomized Controlled Trial

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Conflict of interest: Nil

Abstract

Background: Postpartum haemorrhage remains an important cause of maternal morbidity and mortality, particularly after caesarean delivery. Effective prophylactic uterotonics are therefore essential. Carbetocin, a long-acting oxytocin analogue, may provide sustained uterine contraction and reduce the need for additional interventions. Its prolonged action may offer clinical advantages over conventional oxytocin during the immediate postoperative period.

Aims & Objectives: To compare the haemodynamic effects of carbetocin and oxytocin and assess their efficacy in preventing postpartum haemorrhage following caesarean section.

Material & Methods: This randomized controlled trial was conducted in the Department of Obstetrics and Gynaecology, Basaveshwara Medical College and Hospital, Chitradurga, from August 2022 to March 2024. A total of 240 women beyond 37 weeks undergoing caesarean section were allocated equally: 120 received intramuscular carbetocin and 120 received intravenous oxytocin infusion. Haemodynamic parameters, uterine tone, additional uterotonic requirement, perioperative haemoglobin and blood transfusion were evaluated. Statistical analysis was performed using Microsoft Excel and SPSS, with data presented in percentages.

Results: Second-line uterotonics were required in 45.0% of the oxytocin group but in none receiving carbetocin. At 24 hours, very good uterine tone was observed in 42.5% with carbetocin versus 32.5% with oxytocin. Mean postoperative haemoglobin was 10.9 g/dL and 8.9 g/dL, respectively, with a statistically significant difference. Blood transfusion was required in 5.0% of oxytocin recipients and none receiving carbetocin.

Conclusion: Carbetocin demonstrated favourable efficacy in maintaining uterine tone, limiting haemoglobin decline, reducing additional uterotonic use and minimizing transfusion requirements after caesarean delivery.

Keywords: Carbetocin, Oxytocin, Postpartum Haemorrhage, Caesarean Section, Uterine Tone.

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Introduction

Postpartum haemorrhage (PPH) remains one of the most important preventable causes of maternal morbidity and mortality worldwide. It may occur following either vaginal or caesarean delivery and can rapidly progress to haemodynamic instability, severe anaemia, requirement for blood transfusion, multiorgan dysfunction and death when effective management is delayed. [1,2] Primary PPH affects a substantial proportion of women globally and continues to impose a particularly significant burden in resource-limited settings. [3] Available evidence indicates that haemorrhage contributes considerably to maternal deaths, emphasizing the importance of effective preventive strategies during and immediately after childbirth. [4,5] Uterine atony represents the predominant mechanism underlying PPH, accounting for a major proportion of cases. [6-8] Failure of the myometrium to contract adequately after placental separation prevents effective compression of uterine vessels and consequently facilitates continued bleeding. Risk may be increased by uterine overdistension, prolonged or augmented labour, anaemia, placental abnormalities, higher parity and caesarean delivery.

Nevertheless, PPH may also occur without clearly identifiable antenatal risk factors, making universal preventive measures clinically important. [6] The early postpartum period is particularly critical because a substantial proportion of maternal deaths associated with obstetric hemorrhage occur shortly after delivery. [9]

Active management of the third stage of labour, particularly prophylactic administration of an effective uterotonic, is therefore central to reducing PPH. Oxytocin is widely used because it produces prompt myometrial contraction; however, its relatively short half-life may necessitate prolonged infusion or repeated administration. Higher doses may additionally produce hypotension, nausea, vomiting, cardiovascular disturbances and water intoxication. [9,10] Carbetocin, a longer-acting oxytocin analogue, offers sustained uterotonic activity and may reduce the requirement for supplementary uterotonics following caesarean delivery. Consequently, comparing Carbetocin with conventional oxytocin is clinically relevant for identifying an effective strategy to maintain uterine tone, minimize postpartum blood loss and improve maternal outcomes after caesarean section.

Literature Review: Postpartum haemorrhage remains a major obstetric concern, with uterine atony representing an important preventable mechanism. Pharmacological research into uterotonic agents has therefore focused on achieving rapid, sustained myometrial contraction while maintaining maternal haemodynamic stability. Atke and Vilhardt demonstrated the potent uterotonic activity and receptor affinity of carbetocin, providing an important pharmacological basis for its clinical application. [11] Trends reported from high-resource settings further demonstrate that postpartum haemorrhage continues to require effective and standardized preventive strategies. [12]

Attilakos et al., in a double-blind randomized trial, directly compared carbetocin with oxytocin following caesarean section and reported a reduced requirement for additional uterotonic treatment with carbetocin, supporting its prolonged uterotonic effect. [13] Variations in third-stage labour management across healthcare systems highlight the continuing need for consistent evidence-based prophylaxis. [14]

PPH can progress rapidly to serious maternal complications, making timely uterotonic administration particularly important. [15]

Clinical experience with carbetocin has further supported its usefulness for preventing postpartum haemorrhage. [16] Historical reports demonstrate that controlling uterine haemorrhage has remained a fundamental objective of obstetric practice for centuries. [17-20] Contemporary evidence has transformed this approach toward systematic prevention, early recognition and active management. Mathai et al. emphasized evidence-based preventive measures for reducing PPH-related maternal morbidity and mortality. [21] Similarly, Güngördük et al. highlighted active management of the third stage of labour, particularly uterotonic administration, as a central preventive strategy. [22] Collectively, these findings provide a strong rationale for evaluating carbetocin against oxytocin for PPH prevention following caesarean delivery.

Aims & Objectives:

The aim of this study is to-

1. To compare the haemodynamic effects of carbetocin and oxytocin.
2. To assess their efficacy in preventing postpartum hemorrhage following caesarean section.

Methodology

Study Design: The present study was designed as a randomized controlled trial conducted in the Department of Obstetrics and Gynaecology, Basaveshwara Medical College and Hospital, Chitradurga, from August 2022 to March 2024, after Institutional Ethics Committee approval.

Study Type: This was a prospective interventional comparative study evaluating carbetocin versus oxytocin for prevention of postpartum haemorrhage following caesarean delivery.

Study Population: The study included 240 eligible pregnant women undergoing caesarean section, with 120 participants allocated to each treatment group in a 1:1 ratio.

Inclusion and Exclusion Criteria:

Inclusion Criteria: Women aged ≥18 years with singleton live pregnancy, gestational age ≥37 weeks, undergoing caesarean delivery and willing to provide informed consent were included. Gestational age was determined from the last menstrual period and confirmed by ultrasonography.

Exclusion Criteria: Women with placenta previa, multiple gestation, placental abruption, hypertensive disorders of pregnancy, pre-eclampsia, moderate anaemia, epilepsy, or known cardiac, renal or hepatic disease were excluded.

Data Collection Methods: Data were collected using detailed clinical history and relevant obstetric information. Haemodynamic parameters, uterine tone, haemoglobin levels, additional uterotonic requirement, postpartum blood loss and

requirement for blood transfusion were documented systematically.

Procedure: Participants were allocated sequentially in a 1:1 ratio. Group A received 100 µg intramuscular carbetocin as a bolus**,** while Group B received 40 IU oxytocin in 1000 mL of 0.9% NaCl intravenously at 150 mL/hour after caesarean delivery.

All participants underwent combined spinal-epidural anaesthesia. Blood pressure was assessed after anaesthesia and at 1, 3 and 5 minutes following uterotonic administration, during uterine repair and at completion of surgery. Uterine tone was evaluated at 2, 12 and 24 hours. Haemoglobin was compared between admission and 24 hours summarisedpostpartum, and blood loss ≥1000 mL was considered haemorrhage.

Data Analysis: All data were summarized as mean ± standard deviation or median, as appropriate. Mann–Whitney test, Chi-square test and Fisher's exact test were applied according to data characteristics. A p-value <0.05 was considered statistically significant.

Observations & Results:

Demographic and Clinical Characteristics

Table 1: Comparison of Diastolic Blood Pressure between Carbetocin and Oxytocin Groups (n = 240)

Time point	Carbetocin (n=120), Mean ± SD (mmHg)	Oxytocin (n=120), Mean ± SD (mmHg)	t-value	p-value
Skin incision	71.6 ± 9.1	72.0 ± 7.1	0.371	0.711
1 min after uterotonic	68.3 ± 5.9	71.1 ± 11.5	2.336	**0.020***
3 min after uterotonic	64.7 ± 8.0	60.7 ± 9.9	3.42	**0.001***
5 min after uterotonic	64.7 ± 7.1	64.4 ± 9.0	0.223	0.824
Uterine repair	66.8 ± 6.2	63.2 ± 8.5	3.698	**<0.001***
Skin suturing	67.9 ± 3.8	63.4 ± 9.0	5.015	**<0.001***
12 hours after CS	69.9 ± 3.2	64.6 ± 8.5	6.382	**<0.001***
24 hours after CS	69.3 ± 2.9	67.7 ± 6.3	2.515	**0.013***

Statistically Significant at p < 0.05

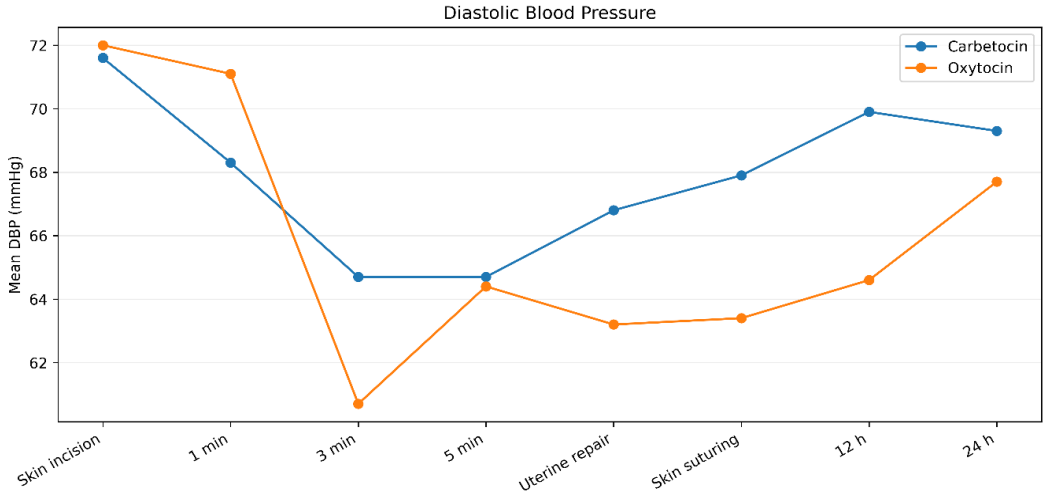

Figure 1: Diastolic blood pressure

Interpretation: Baseline diastolic blood pressure was comparable between groups. Following uterotonic administration, significant differences emerged at several clinically relevant time points. Carbetocin maintained relatively higher diastolic pressure at 3 minutes, uterine repair, skin suturing, and at 12 and 24 hours after caesarean section. These findings indicate a favourable and sustained haemodynamic profile with carbetocin, while confirming that both treatments produced measurable perioperative cardiovascular responses.

Table 2: Requirement for Second-Line Uterotonic Drugs (n = 240)

Second-line uterotonic	Carbetocin (n=120), n (%)	Oxytocin (n=120), n (%)	χ^2	Df	p
No	120 (100.0)	66 (55.0)	**69.677;**	**1**	**<0.001**
Yes	**0 (0.0)**	**54 (45.0)**			
Total	**120 (100)**	**120 (100)**			

Statistically Significant at p < 0.05

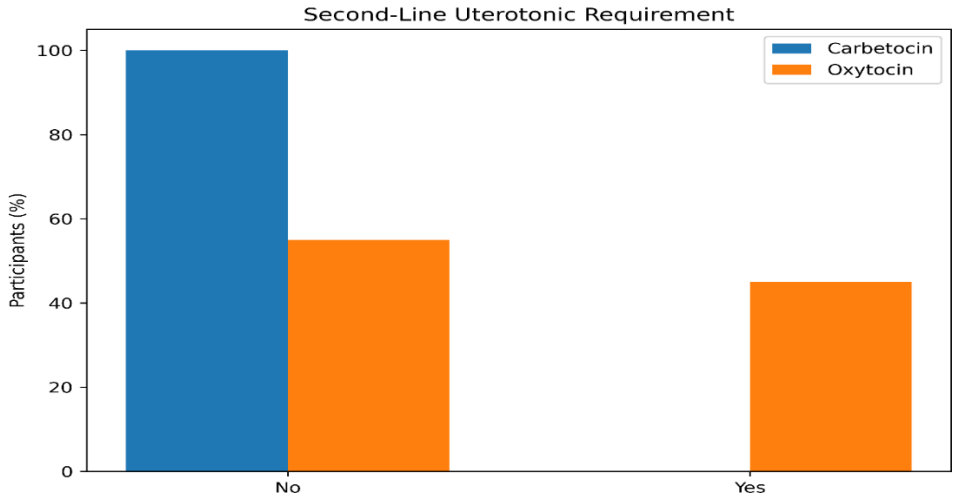

Figure 2: Second-Line Uterotonic requirement

Interpretation: A marked difference was observed in the requirement for rescue uterotonic therapy. None of the 120 women receiving carbetocin required a second-line uterotonic, whereas 54 women (45.0%) receiving oxytocin required additional medication. The difference was highly statistically significant ($p<0.001$).

This finding strongly favours carbetocin in terms of sustained uterotonic effectiveness and suggests that a single administration provided adequate uterine support in the studied population.

Table 3: Comparison of Uterine Tone at 2, 12 and 24 Hours (n = 240)

Time	Uterine tone	Carbetocin n (%)	Oxytocin n (%)	χ^2	Df	p
2 hours	Atony	18 (15.0)	34 (28.3)	8.346	3	0.039*
	Good	26 (21.7)	21 (17.5)			
	Sufficient	45 (37.5)	46 (38.3)			
	Very good	31 (25.8)	19 (15.8)			
12 hours	Atony	12 (10.0)	22 (18.3)	6.981	3	0.072
	Good	21 (17.5)	21 (17.5)			
	Sufficient	44 (36.7)	50 (41.7)			
	Very good	43 (35.8)	27 (22.5)			
24 hours	Atony	6 (5.0)	7 (5.8)	5.253	3	0.154
	Good	30 (25.0)	25 (20.8)			
	Sufficient	33 (27.5)	49 (40.8)			
	Very good	51 (42.5)	39 (32.5)			

Statistically Significant at $p < 0.05$

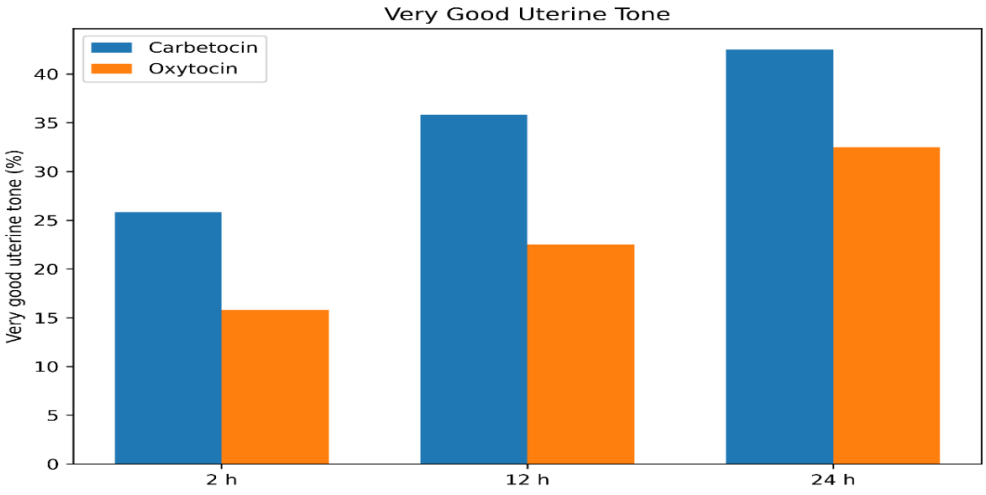

Figure 3: Very good uterine tone

Interpretation: Carbetocin demonstrated a favorable pattern of sustained uterine contractility. At two hours, uterine atony was lower with carbetocin (15.0%) than oxytocin (28.3%), with a statistically significant overall difference (p=0.039). Very good tone progressively increased with carbetocin from 25.8% at two hours to 42.5% at 24 hours. Although later comparisons were not statistically significant, the observed distribution consistently supports satisfactory maintenance of uterine tone.

Table 4: Pre- and Post-operative Hemoglobin Levels - (n = 240)

Haemoglobin	Carbetocin (n=120), Mean ± SD	Oxytocin (n=120), Mean ± SD	t-value	p-value
Pre-operative Hb (g/dL)	11.73 ± 0.9	11.9 ± 1.8	1.69	0.092
Post-operative Hb (g/dL)	**10.9 ± 0.9**	**8.9 ± 0.9**	17.162	**<0.001***

Statistically Significant at p < 0.05

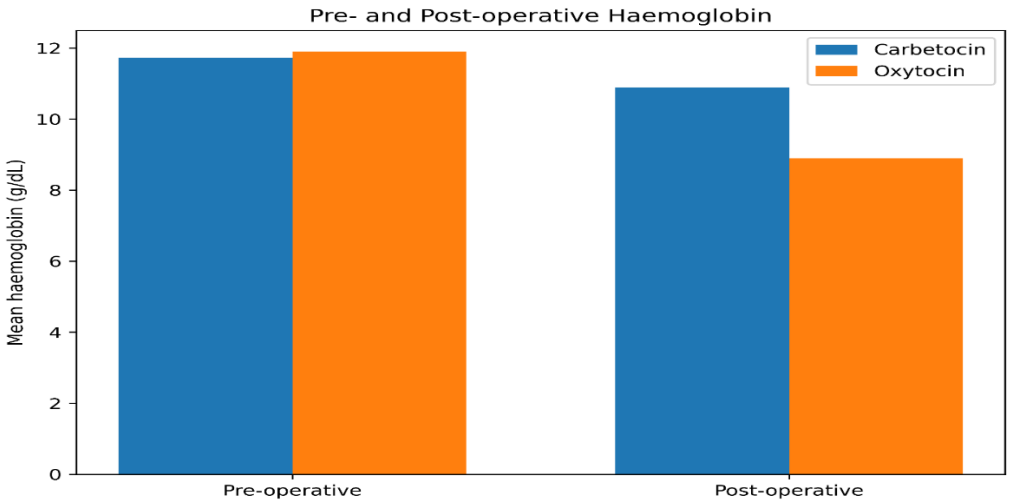

Figure 4: Pre and Post-operative Haemoglobin

Interpretation: Pre-operative haemoglobin levels were comparable between the groups, with no statistically significant difference (p=0.092), providing an appropriate baseline for postoperative comparison. Following caesarean delivery, mean haemoglobin remained substantially higher in the carbetocin group (10.9±0.9 g/dL) than in the oxytocin group (8.9±0.9 g/dL), with a highly significant difference (p<0.001). The finding favours carbetocin and indicates better preservation of postoperative haemoglobin in this study.

Table 5: Requirement for Blood Transfusion (n = 240)

Blood requirement	Carbetocin (n=120), n (%)	Oxytocin (n=120), n (%)	χ^2	Df	p
No	**120 (100.0)**	114 (95.0)	6.154	1	0.013
Yes	**0 (0.0)**	**6 (5.0)**			
Total	**120 (100)**	**120 (100)**			

Statistically Significant at p < 0.05

Interpretation: Blood transfusion was not required in any participant receiving carbetocin, whereas six women (5.0%) in the oxytocin group required transfusion. This difference was statistically significant (p=0.013). Together with the significantly higher postoperative haemoglobin observed in the carbetocin group, this outcome provides clinically meaningful evidence favouring carbetocin for limiting haemorrhage-related consequences following caesarean delivery and potentially reducing the need for blood-product support in the postoperative period.

Discussion

Postpartum haemorrhage continues to represent a major challenge in obstetric practice, with considerable variation in prevalence across regions and healthcare settings. Calvert et al. demonstrated substantial geographic differences in PPH burden, reinforcing the need for effective, context-appropriate preventive strategies. [23] Accurate estimation of blood loss also remains essential because visual assessment may underestimate clinically important haemorrhage; standardized approaches can improve recognition and timely intervention. [24] In India, although maternal

mortality has declined over recent decades, obstetric haemorrhage remains an important contributor, highlighting the continuing relevance of preventive uterotonic therapy. [25] In the present randomized study, carbetocin showed several favourable clinical outcomes compared with oxytocin after caesarean delivery. None of the women in the carbetocin group required a second-line uterotonic, whereas 45.0% of women receiving oxytocin did, with a highly significant difference. This finding supports the value of sustained uterine stimulation in preventing atony and reducing escalation of treatment. Evidence-based management of primary PPH similarly emphasizes rapid uterotonic therapy as a central component of haemorrhage control. [26] Preventive medical strategies during caesarean section are particularly important because surgical delivery inherently carries a greater risk of significant blood loss. [27]

The haemodynamic findings were also clinically relevant. Carbetocin maintained comparatively favourable diastolic blood pressure at several perioperative and postoperative time points. These observations should be interpreted in the context of the physiological cardiovascular adaptations of pregnancy, which influence maternal tolerance to changes in circulating volume and vascular resistance. [28] Surgical technique and adequate uterine closure may additionally influence intraoperative haemostasis and postoperative blood loss. [29]

A particularly important finding was the preservation of postoperative haemoglobin. Mean postoperative haemoglobin was 10.9±0.9 g/dL with carbetocin compared with 8.9±0.9 g/dL with oxytocin ($p<0.001$). Accurate blood-loss measurement methods remain important when interpreting such outcomes. [30] Furthermore, network meta-analysis of uterotonic agents has demonstrated meaningful differences in prophylactic effectiveness across available therapies. [31] Carbetocin's prolonged oxytocin-receptor activity provides a plausible pharmacological explanation for its sustained uterotonic effect. [32]

Finally, no participant receiving carbetocin required blood transfusion, compared with 5.0% in the oxytocin group ($p=0.013$). Taken together, the present findings favour carbetocin as an effective prophylactic uterotonic following caesarean section, particularly for reducing additional uterotonic use, maintaining uterine tone, preserving postoperative haemoglobin and limiting transfusion requirements.

Implications for Clinical Practice: The findings support carbetocin as an effective prophylactic uterotonic during caesarean delivery. Its sustained uterine action may reduce the requirement for additional uterotonics, improve maintenance of uterine tone, preserve postoperative haemoglobin, and decrease blood transfusion requirements. Incorporating carbetocin into appropriate obstetric protocols may therefore strengthen PPH prevention, simplify postoperative management, reduce haemorrhage-related interventions, and contribute to safer maternal outcomes following caesarean section.

Limitations: This study was conducted at a single tertiary-care institution, which may limit the generalizability of its findings to different obstetric populations and healthcare settings. The assessment was restricted to the immediate perioperative and 24-hour postpartum period, preventing evaluation of longer-term maternal outcomes. Additionally, selected high-risk pregnancies were excluded. Nevertheless, the randomized comparative design, adequate sample size, standardized treatment protocol, and objective clinical outcomes strengthen the reliability and clinical relevance of the findings.

Conclusion

The present study concludes that carbetocin is an effective and clinically favourable uterotonic for preventing postpartum haemorrhage following caesarean delivery. Compared with oxytocin, carbetocin demonstrated sustained uterine contractility, substantially reduced the requirement for additional uterotonic therapy, and provided better preservation of postoperative haemoglobin. Importantly, none of the women receiving carbetocin required blood transfusion, while transfusion was required in the oxytocin group.

These findings support carbetocin as a valuable prophylactic option that may strengthen haemorrhage prevention, reduce treatment escalation, and contribute to improved maternal safety and postoperative outcomes following caesarean section.

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