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Original Article

Comparative Analysis of Carbetocin and Oxytocin in the Prevention of Postpartum Hemorrhage following Caesarean Section

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Abstract

Introduction: Postpartum haemorrhage (PPH) remains a leading cause of maternal morbidity and mortality, particularly in caesarean deliveries. Oxytocin is widely used but limited by its short half-life and instability. Carbetocin, a long-acting analogue, offers sustained uterotonic effect and may reduce the need for repeated dosing. This study compared the efficacy of carbetocin versus oxytocin in preventing PPH during caesarean section. ***Method:*** A randomized comparative study was conducted at Holy Family Hospital, New Delhi, from February 2023 to January 2024. A total of 144 full-term women undergoing elective or emergency caesarean section were randomly allocated into two groups: Group A received carbetocin 100 µg IV, and Group B received oxytocin 20 IU IV infusion. Primary outcomes included intraoperative and postoperative blood loss, haemoglobin drop, and need for additional uterotonics. Secondary outcomes included surgical interventions, transfusion, maternal morbidity, neonatal outcomes, and side effects. ***Result:*** Group A had significantly lower mean blood loss (527.2 ± 58.1 ml vs 598.9 ± 138.4 ml; p=0.0001), smaller haemoglobin drop (0.62 ± 0.49 g/dl vs 0.91 ± 0.74 g/dl; p=0.019), and reduced need for additional uterotonics (15.3% vs 66.7%; p<0.0001). Neonatal Apgar scores were higher in Group A, while complications and maternal side effects were comparable. ***Conclusion:*** Carbetocin is more effective than oxytocin in reducing blood loss and need for additional uterotonics during caesarean section, with comparable safety.

Keywords: ***Caesarean section; Carbetocin; Oxytocin; Postpartum haemorrhage; Uterotonics***

Introduction

Postpartum haemorrhage (PPH) remains one of the leading causes of maternal morbidity and mortality worldwide, particularly in developing countries where access to advanced obstetric care is limited. The World Health Organization (WHO) estimates that PPH accounts for nearly one-quarter of all maternal deaths globally, making its prevention a critical component of safe motherhood initiatives. Caesarean section, although lifesaving, further increases the risk of intraoperative and postoperative blood loss, underscoring the importance of effective uterotonic agents in its prevention [2].

Oxytocin has long been regarded as the gold standard uterotonic for the active management of the third stage of labour and prevention of PPH. However, its relatively short half-life, need for continuous intravenous infusion, and susceptibility to degradation in hot climates limit its utility, especially in resource-constrained settings. Carbetocin, a long-acting synthetic analogue of oxytocin, offers potential advantages in this regard. With a half-life approximately four to ten times longer than oxytocin, carbetocin provides sustained uterotonic activity after a single administration, thereby reducing the need for repeated dosing or infusion [3].

Several studies have compared the effectiveness of carbetocin and oxytocin in preventing PPH, with carbetocin showing promising results in reducing the need for additional uterotonics and maintaining better haemodynamic stability. However, variations in outcomes across populations and healthcare settings show the need for further comparative studies, particularly in women undergoing caesarean section a group inherently at higher risk of significant blood loss [4].

With this background, the present study aims to compare the efficacy of carbetocin with oxytocin in preventing PPH in women undergoing caesarean section. The evaluation focuses on intraoperative and postoperative blood loss, requirement of additional uterotonics, change in haemoglobin levels, and maternal morbidity parameters such as PPH, sepsis, and hematoma.

Method

This prospective, randomized, comparative observational study was conducted in the Department of Obstetrics and Gynaecology, Holy Family Hospital, New Delhi, a 332-bedded multi-specialty tertiary care center established in 1953 by the Medical Mission Sisters and

managed by the Delhi Catholic Archdiocese. The hospital is well equipped with modern facilities, and its Obstetrics and Gynaecology department is staffed with experienced professionals, providing an appropriate setting for the present study. The study was carried out over a period of 12 months, from February 2023 to January 2024.

A total of 144 full-term pregnant women scheduled for caesarean section were recruited after fulfilling the inclusion and exclusion criteria. The sample size was calculated based on the study by Shakila Yesmin *et al.*, which reported a mean per-operative blood loss of 363.3 ± 107.4 ml in the intervention group and 441.3 ± 209.6 ml in the standard treatment group. Using these values, with 80% power and a 5% level of significance, the minimum required sample size was determined to be 72 patients per group. The pooled standard deviation was calculated as 166.53, and the formula for comparing means of two groups yielded a sample size of 71.48, which was rounded up to 72 per group. Thus, a total of 144 participants were included in the study.

Participants were recruited voluntarily after obtaining written informed consent. A detailed history including age, parity, period of gestation, obstetric and menstrual history, past and family history was recorded. General and systemic examinations were carried out, including height, weight, BMI, vitals, and per-abdominal examination. Baseline investigations such as complete blood count (CBC), blood grouping, prothrombin time (PT), activated partial thromboplastin time (APTT), thyroid-stimulating hormone (TSH), random blood sugar (RBS), liver function test (LFT), kidney function test (KFT), non-stress test (NST), and ultrasonography (USG) were performed as required.

Randomization was done using a computer-generated technique with the RANDBETWEEN function, assigning participants to either Group A or Group B. If the number generated was "1", the participant was allocated to Group A (Carbetocin group), and if "2", to Group B (Oxytocin group). Once one group reached 72 participants, the remaining were allocated to the other group. Group A received 100 µg of carbetocin intravenously, administered slowly after delivery of the baby during caesarean section, while Group B received 20 IU of oxytocin diluted in 1000 ml of Ringer's lactate solution as an intravenous infusion after delivery of the baby. All procedures were performed under spinal anaesthesia.

Blood loss was measured intraoperatively from placental delivery until the end of surgery using the gravimetric method. Soaked mops and perineal sheets were weighed before and after use, and blood collected in calibrated suction jars was recorded after excluding amniotic fluid. Total blood loss was calculated as the sum of blood absorbed by mops and sheets plus the suctioned blood, with 1 g of weight equated to 1 ml of blood. Postoperative blood loss over 24 hours was estimated by weighing sanitary pads. Complete blood count was repeated at 24 hours postoperatively for haemoglobin comparison. The requirement for additional uterotonics, blood transfusion, and any surgical interventions for excessive bleeding were also recorded. Patients were observed in the postoperative period for complications such as sepsis, haematoma, or excessive vaginal bleeding until discharge.

Inclusion criteria were singleton pregnancies at term (37–40 weeks of gestation). Exclusion criteria included suspected placental pathology (placenta previa, accreta, abruption), haematological disorders such as thrombocytopenia, coagulation defects or haemoglobinopathies, medical comorbidities (cardiac, renal, hepatic, or endocrine diseases), hypertensive disorders of pregnancy including pre-eclampsia, multiple gestations, hypersensitivity to study drugs, classical caesarean section, uterine rupture, uterine fibroids, and those undergoing caesarean section under general anaesthesia.

Data were entered into Microsoft Excel and analysed using SPSS version 25.0. Categorical variables were expressed as frequency and percentage, while continuous variables were presented as mean ± standard deviation or median as appropriate. Normality of distribution was assessed using the Kolmogorov–Smirnov test. Quantitative variables were compared using the independent t-test or Mann–Whitney U test, while categorical variables were compared using the chi-square test or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

Result

The study was conducted at Holy Family Hospital, New Delhi, involving 144 women with singleton term pregnancies (37–40 weeks), randomly assigned to two groups: Group A (carbetocin, 100 µg IV) and Group B (oxytocin, 20 IU IV infusion).

Table 1: Demographic and Baseline Characteristics

Parameter	Group A (n=72)	Group B (n=72)	P value
Age (mean ± SD, yrs)	30.53 ± 4.66	30.21 ± 4.87	0.688
Age distribution (%)	20–30: 50	20–30: 58.33	0.287
	31–40: 48.61	31–40: 37.50	
	41–45: 1.39	41–45: 4.17	
Height (cm)	157.06 ± 7.4	158.57 ± 7.97	0.24
Weight (kg)	67.14 ± 6.22	65.51 ± 7.59	0.162
BMI	27.35 ± 3.21	26.26 ± 3.94	0.07
BMI categories (%)	Underweight: 0	Underweight: 4.17	0.438
	Normal: 23.61	Normal: 19.44	
	Overweight: 59.72	Overweight: 61.11	
	Obese: 16.67	Obese: 15.28	
Gestation weeks (mean ± SD)	38.16 ± 0.56	38.29 ± 0.95	0.344
Gestation distribution (%)	37–40: 100	37–40: 98.61	1
	>40: 0	>40: 1.39	
Primigravida (%)	30.56	54.17	0.004
Multigravida (%)	69.44	45.83	

The study results show that both groups were generally comparable in demographic and baseline parameters, with no significant differences in age, height, weight, BMI, or period of gestation; however, Group A had more multigravida and fewer primigravida participants compared to Group B, as shown in Table 1.

Table 2: Indication for Caesarean Section

Indication	Group A (n=72)	Group B (n=72)	P value
Previous LSCS with thin scar	58.3%	43.1%	0.04
Breech presentation	11.1%	4.2%	
IVF conception with failed induction	2.8%	2.8%	
Contracted pelvis	2.8%	1.4%	
Poor bishop score with previous LSCS	2.8%	1.4%	
CDMR	5.6%	5.6%	
LGA baby	0%	1.4%	
Fetal distress	9.7%	30.6%	
BOH	1.4%	0%	
NPOL	5.6%	9.7%	

Regarding the indications for caesarean section, prior LSCS with thin scar and fetal distress were more common indications in Group A and Group B respectively, with previous LSCS showing a statistically significant difference between groups (Table 2).

Table 3: Intraoperative and Hematological Outcomes

Parameter	Group A	Group B	P value
Hemoglobin before surgery	11.1 ± 1.0	11.6 ± 1.2	0.008
Hemoglobin after surgery	10.5 ± 1.1	10.7 ± 1.2	0.314
Net drop in Hb	0.62 ± 0.49	0.91 ± 0.74	0.019
Surgery duration (min)	58.5 ± 6.3	60.3 ± 7.2	0.112
Total blood loss (ml)	527.2 ± 58.1	598.9 ± 138.4	<0.001
Median blood loss (ml, IQR)	525 (487.5–560)	570 (530–612.5)	<0.001
Blood loss range (ml)	450–880	480–1300	<0.001
Additional uterotonics (%)	15.3	66.7	<0.001

Intraoperative and hematological outcomes showeded that Group A experienced significantly less net drop in hemoglobin and lower total blood loss compared to Group B, and required additional uterotonics far less frequently; these findings are detailed in Table 3.

Table 4: Other Surgical Interventions

Intervention	Group A (n=72)	Group B (n=72)	P value
Nil	88.9%	83.3%	0.723
Adhesiolysis	9.7%	13.9%	
B/L Uterine artery ligation	1.4%	1.4%	
Left salpingo-oophorectomy	0%	1.4%	

Surgical interventions such as adhesiolysis and uterine artery ligation were similar across groups, with most patients not needing extra procedures (Table 4).

Table 5: Neonatal Outcomes

Parameter	Group A (n=72)	Group B (n=72)	P value
Birth weight (kg)	2.94 ± 0.40	2.94 ± 0.41	0.977
APGAR at 1 min (mean ± SD)	8.1 ± 0.8	7.8 ± 0.8	0.017
APGAR at 5 min (mean ± SD)	9.1 ± 0.6	8.9 ± 0.4	0.003
Neonatal complications (nil)	87.5%	76.4%	0.322
Respiratory distress	5.6%	9.7%	
Transient tachypnea of newborn	1.4%	5.6%	
Neonatal jaundice	1.4%	2.8%	

Neonatal outcomes were broadly comparable, with no meaningful difference in birth weights and complication rates, though Group A showed slightly higher APGAR scores at both 1 and 5 minutes after birth (Table 5).

Table 6: Urine Output in 24 Hours

Parameter	Group A	Group B	P value
Mean ± SD (ml)	2259.72 ± 307.38	2304.17 ± 292	
Median (IQR) (ml)	2275 (2050–2500)	2300 (2100–2512.5)	0.375
Range	1650–2900	1700–2800	

Urine output in the first 24 hours post-surgery was similar between groups, with no significant differences in means, medians, or ranges (Table 6).

Discussion

Postpartum hemorrhage (PPH) remains a leading cause of maternal morbidity and mortality worldwide, despite declining maternal deaths in recent years. Active management of the third stage of labor is critical in preventing PPH, with uterotonics reducing its risk by nearly 60% [5]. Although oxytocin is the first-line agent, there is no universal gold standard, and the choice of uterotonic varies across clinical practice [6]. Carbetocin, a long-acting oxytocin analogue with sustained uterotonic activity for approximately three hours, has emerged as a promising alternative [7,8].

The present randomized comparative study evaluated the efficacy and safety of intravenous carbetocin versus oxytocin in women undergoing cesarean delivery at term. Both groups were comparable with respect to baseline maternal characteristics, including age, BMI, and gestational age, consistent with findings from previous studies [7,9,10]. The distribution of parity differed between groups, with a higher proportion of multigravida in the carbetocin group, showing trends reported in earlier trials [9,7].

One of the most significant findings of this study was the reduction in intraoperative blood loss with carbetocin. Women receiving carbetocin had a mean blood loss of 527 ml compared to 599 ml in the oxytocin group (p=0.0001). These findings are similar to previous trials, which consistently showeded lower blood loss with carbetocin compared to oxytocin [11,7,10]. The smaller mean hemoglobin drop observed in the carbetocin group (0.62 g/dl vs. 0.91 g/dl, p=0.019) further supports its superior hemostatic efficacy, in agreement with Esseissah *et al.*, Ahmed *et al.*, and Taheripanah *et al.* [12,13,10].

The requirement for additional uterotonics was also markedly lower in the carbetocin group (15.3% vs. 66.7%, p<0.0001). This finding is consistent with previous reports [14-16], showing carbetocin's ability to sustain uterine tone and reduce the need for supplementary agents. By contrast, the need for additional surgical interventions, incidence of PPH, and requirement for blood transfusion were comparable between the two groups, as observed in other studies [12,13,9].

Neonatal outcomes were generally favorable in both groups. Infants born to mothers receiving carbetocin showeded significantly higher Apgar scores at both one and five minutes, although the incidence of neonatal complications did not differ between groups. These results are consistent with the existing literature, showing that carbetocin is not associated with adverse neonatal outcomes [12,9].

In terms of maternal safety, side effects such as nausea, vomiting, headache, and tachycardia were observed at similar frequencies in both groups, comparable with earlier studies [13,7]. There was no serious maternal morbidity (such as sepsis or hematoma) was reported in either group. Although oxytocin is associated with potential cardiovascular and antidiuretic effects, including hyponatremia and water intoxication [7,5,17-19], our study found no significant differences in 24-hour urine output between carbetocin and oxytocin groups (2259 vs. 2304 ml, p=0.375). While Larciprete *et al.* [20] and others [7,21] have reported advantages of carbetocin in maintaining diuresis, our findings did not confirm this effect.

Overall, our findings confirm that carbetocin is associated with significantly lower blood loss, reduced hemoglobin drop, and decreased need for additional uterotonics compared to oxytocin, while maintaining comparable safety and neonatal outcomes. These results reinforce the evidence supporting carbetocin as an effective and safe alternative for PPH prevention following cesarean delivery.

Strengths and Limitations

The major strength of this study lies in its randomized comparative design, which minimized selection bias and ensured comparable baseline characteristics between groups. In addition, the inclusion of both intraoperative and postoperative blood loss, hemoglobin drop, and maternal as well as neonatal outcomes provided a comprehensive evaluation of efficacy and safety.

However, several limitations should be acknowledged. The study was conducted at a single center with a relatively small sample size, which may limit the generalizability of the findings. The follow-up period was limited to the immediate postpartum period, and long-term maternal outcomes such as delayed PPH were not assessed. Furthermore, as a hospital-based study, results may not fully show outcomes in lower-resource or community settings.

Future Implications

Carbetocin shows promise as an effective alternative to oxytocin in preventing PPH during cesarean section, particularly by reducing intraoperative blood loss and the need for additional uterotonics. Future large-scale, multicentric, double-blind randomized controlled trials are warranted to validate these findings across diverse populations. Economic evaluations are also essential, especially in low- and middle-income countries, to determine whether the higher acquisition cost of carbetocin is justified by its clinical benefits. In addition, studies assessing its role in vaginal deliveries and high-risk pregnancies could broaden its application and further establish its place in obstetric practice.

Conclusion

Carbetocin was found to be more effective than oxytocin in reducing intraoperative blood loss, hemoglobin drop, and the need for additional uterotonics during cesarean section. Although the incidence of PPH, need for transfusion, and surgical interventions were comparable, overall maternal outcomes favored carbetocin. Neonatal Apgar scores were significantly better in the carbetocin group, while side effects and complications were similar between both agents. These findings support carbetocin as a safe and reliable alternative to oxytocin for prevention of PPH. Larger multicentric studies are recommended to confirm these results and assess cost-effectiveness.

Declarations

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Conflict of Interest

None Declared

Ethical Approval

Done

Author Contributions

Dr. Dhruv Desai conceptualized and designed the study, supervised data collection, and performed the statistical analysis. He also took the lead in drafting and revising the manuscript for intellectual content.

Dr. Ruta Chaudhary contributed to patient recruitment, clinical data collection, and assisted in data interpretation. She also reviewed and provided critical feedback on the final manuscript.

Dr. Atul Pawar participated in study design, contributed to literature review and methodology development, and assisted in manuscript preparation and editing. All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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