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Comparison of the efficacy of oxytocin and carbetocin in the prevention of post-operative haemorrhage after caesarean section

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Abstract

Introduction and Objective. Postpartum haemorrhage (PPH) is the leading preventable cause of maternal mortality, with uterine atony as its primary cause in caesarean sections. Compared to standard oxytocin, carbetocin offers a more sustained uterotonic effect. The aim of the study is to compare the clinical efficacy of prophylactic carbetocin versus oxytocin in high-risk caesarean deliveries.

Materials and Method. This prospective, randomized controlled study was conducted with 100 pregnant women presenting with high-risk factors for PPH (multiple gestation, macrosomia, polyhydramnios, prolonged labour, history of uterine atony). The cases were divided into two equal groups: the control group (n=50) received a standard oxytocin infusion, and the study group (n=50) received a single dose (100 µg) of carbetocin prophylaxis. Demographic characteristics, postoperative laboratory parameters, the need for additional uterotonics, and the requirement for blood transfusions were compared between the groups.

Results. The need for additional uterotonics (oxytocin) was found to be significantly lower in the carbetocin group at 4%, compared to 30% in the standard oxytocin group ($p<0.01$). The requirement for blood transfusion was 4% in the carbetocin group and 26% in the control group ($p>0.05$).

Conclusions. Single-dose carbetocin is significantly more effective than standard oxytocin at for maintaining uterine contraction and decreasing the need for additional uterotonics in high-risk cesarean deliveries. The results indicate that carbetocin is a robust alternative for optimizing postpartum haemorrhage (PPH) management and reducing clinical workload.

Key words

caesarean section, postpartum haemorrhage, uterotonics, oxytocin, carbetocin

INTRODUCTION

Postpartum haemorrhage (PPH) is one of the most common and preventable causes of maternal mortality worldwide. PPH is directly responsible for approximately one-third of maternal deaths occurring during pregnancy, labor, or the first 42 days postpartum [1, 2].

Clinically, postpartum haemorrhage is defined as blood loss exceeding 500 mL following vaginal delivery, and 1,000 mL during or after a caesarean section [3]. While the World Health Organization (WHO) defines PPH as blood loss of 500 mL or more within the first 24 hours after birth, severe PPH is defined as loss of 1,000 mL or more, and massive PPH as loss exceeding 2,500 mL or blood loss leading to hypovolemic shock. PPH remains a leading cause of maternal morbidity and mortality, particularly in developing countries, and represents the primary cause of maternal deaths worldwide [4].

There has been a significant global increase in caesarean section rates in recent years. As caesarean operations carry a higher risk of complications compared to vaginal delivery, PPH is among the most frequent and serious risks encountered [5]. Affecting approximately 6% of births worldwide, PPH is the primary cause of preventable maternal deaths [6]. Caesarean section is recognized as one of the most significant risk factors for postpartum haemorrhage (PPH). The rising rates of caesarean sections in developed countries have further underscored the clinical importance of this risk. While the traditional diagnostic criteria for PPH involve blood loss exceeding 500 mL for vaginal births and 1,000 mL for caesarean sections, current clinical guidelines suggest a more comprehensive approach. It is recommended that diagnosis should not rely solely on blood loss volume, but should also incorporate the assessment of changes in haematocrit levels, the necessity for blood transfusion, and the patient's overall haemodynamic stability [7–9].

The primary cause of postpartum haemorrhage is uterine atony, defined as the failure of the uterus to contract adequately following delivery. Active management of the third stage of labour and the use of prophylactic uterotonic agents are vital for significantly reducing the incidence of such bleeding. While oxytocin remains the standard, first-line, and evidence-based choice for both vaginal and

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caesarean deliveries, recent Cochrane data indicate that combinations of ergometrine plus oxytocin and misoprostol plus oxytocin may be more effective in preventing PPH. However, these agents (with the exception of carbetocin) are associated with higher side-effect profiles compared to oxytocin. Therefore, it is vital in clinical practice to strike a balance between the efficacy of preventing PPH and the risk of side-effects, tailored to the patient's condition [10–12].

Carbetocin is a long-acting synthetic analogue of oxytocin that can be administered as a single intravenous or intramuscular injection. When used postpartum, it produces a more sustained and effective contractile effect on the uterus compared to oxytocin. Furthermore, its comparable safety profile to oxytocin and good tolerability among patients are significant advantages of this drug [13].

The main objective of this study is to compare the clinical efficacy of carbetocin and oxytocin in preventing postoperative haemorrhage and reducing the need for additional uterotonics in patients undergoing primary caesarean section who are at high risk for postpartum haemorrhage.

MATERIALS AND METHOD

The study was conducted as a prospective, randomized controlled trial at the Clinic of Obstetrics and Gynaecology of the University of Health Sciences, Training and Research Hospital in Antalya, Turkey. The study population consisted of pregnant women scheduled for a caesarean section who presented with high-risk factors for postpartum haemorrhage (PPH).

Inclusion criteria. The inclusion criteria were defined as: multi-foetal gestation, macrosomia, history of prolonged labour, diagnosis of polyhydramnios, and a history of uterine atony/haemorrhage in previous pregnancies.

Study design and grouping. A total of 100 cases meeting the study criteria were randomly divided into two equal groups: the case group (n=50) and the control group (n=50).

Applied protocols

- Control Group – patients received routine oxytocin infusion following delivery, in accordance with standard clinical procedures.
- Case Group – patients received a single prophylactic dose (100 μg) of carbetocin after delivery.

Parameters followed and data collection. The following data regarding the clinical progression of the patients were recorded:

Haematological parameters. Complete blood count results (haemoglobin [Hb], haematocrit [Hct], leukocyte [WBC], platelet [PLT]) obtained preoperatively and 24 hours post-operatively.

Demographic and clinical characteristics. Socio-demographic data and indications for caesarean section.

Need for further treatment. Requirement for additional uterotonics (oxytocin) and the necessity for blood transfusion.

Statistical analysis. Data were analyzed using the SPSS 23.0 software package. Demographic information and laboratory findings of the participants were summarized using frequency and percentage distributions.

- Mann-Whitney U test and Kruskal-Wallis test were used to compare quantitative variables.
- Chi-Square and Fisher's Exact tests were employed for the analysis of categorical variables.
- A p-value of <0.05 was accepted as the level of statistical significance.

Ethical approval. Approval for the study was obtained from the Clinical Research Ethics Committee of the University of Health Sciences, Antalya Training and Research Hospital (Approval No. 9/2, dated 13/06/2024). Necessary institutional permissions were granted. All patients included in the study were provided with both oral and written information regarding the study's purpose, methodology, and processes; informed consent forms were signed to ensure voluntary participation. Data were used strictly for scientific purposes in accordance with confidentiality principles and were accessible only to the researchers and advisors.

RESULTS

The study population consisted of 100 patients, with 50 participants assigned to the control (Oxytocin) group and 50 to the study (Carbetocin) group. Socio-demographic, obstetric, and laboratory parameters were analyzed comparatively. General descriptive statistics of the study group, clinical data, such as indications for caesarean section, need for additional oxytocin, and blood transfusion requirements, as well as laboratory findings including age, height, weight, BMI, and blood values, are presented in the Tables.

Descriptive findings of the study groups. The study included 100 participants, with 50% assigned to the case group and 50% to the control group. The most frequently identified indications for caesarean section were a history of uterine atony (49.0%), multifetal pregnancy (17.0%), and macrosomia (17.0%). Regarding the gravidity distribution of the participants, the highest frequencies were observed in the 2nd, 3rd, and 1st pregnancies, respectively. During the delivery process, 17.0% of the participants required additional oxytocin, while 15.0% were found to require postpartum blood transfusion (Tab. 1).

Laboratory and clinical findings. The mean age of the participants in the study group was 30.49 ± 5.89 (range: 17.00–45.00) years, and the mean body mass index (BMI) was 30.34 ± 5.62 kg/m^2. The mean gestational age (ultrasonography) was determined to be 38.13 ± 1.69 weeks.

An examination of the pre-delivery and post-delivery haematological parameters revealed that mean haemoglobin (Hb) levels decreased from 11.66 ± 1.28 g/dL to 10.57 ± 1.39 g/dL, while the mean platelet (PLT) count declined from 227.18 ± 75.67 × 10^3/μL to 194.51 ± 65.15 × 10^3/μL. Conversely, mean leukocyte (WBC) levels increased from 9.91 ± 2.49 × 10^3/μL in the pre-delivery period to 13.83 ± 3.47 × 10^3/μL in the post-delivery period. Other biochemical parameters within the study group (ALT, AST, BUN, CRE,

Table 1. Descriptive Statistics of the Study Group (frequency (n). percent (%))

Variable	Category	Frequency (n)	Percent (%)
Group	Case	50	50.0
	Control	50	50.0
Cesarean Indication	Multifetal Pregnancy	17	17.0
	Macrosomia (Large Infant)	17	17.0
	Prolonged Labor	8	8.0
	History of Atony	49	49.0
	Polyhydramnios	9	9.0
Gravida	1	21	21.0
	2	29	29.0
	3	23	23.0
	≥4	27	27.0
Parity	0	22	22.0
	1	32	32.0
	2	28	28.0
	≥3	18	18.0
Abortus	0	78	78.0
	1	15	15.0
	≥2	7	7.0
Additional Oxytocin	No	83	83.0
	Yes	17	17.0
Blood Transfusion	No	85	85.0
	Yes	15	15.0

Table 2. Descriptive Statistics of Laboratory Data for the Study Group

Variable	Min.	Max.	Mean	SD
AGE	17.00	45.00	30.49	5.89
BMI	12.02	47.05	30.34	5.62
USG	29.10	41.40	38.13	1.69
HB (Pre)	8.20	13.80	11.66	1.28
HTC	26.10	97.00	36.49	6.91
WBC (Pre)	3.00	20.40	9.91	2.49
PLT (Pre)	53.00	484.00	227.18	75.67
NEU	1.92	17.60	7.08	2.13
LYM	0.81	6.85	1.99	0.73
NLR	1.69	16.63	3.78	1.67
ALT	4.00	255.00	16.10	25.81
AST	2.00	180.00	18.27	17.98
BUN	3.70	16.00	7.50	2.41
CRE	0.05	0.84	0.64	0.09
NA	130.00	143.00	136.99	2.51
K	0.67	5.20	4.02	0.45
INR	0.92	10.80	1.26	1.36
HB (Post)	7.00	14.30	10.57	1.39
WBC (Post)	5.10	23.70	13.83	3.47
PLT (Post)	66.00	397.00	194.51	65.15

Na, K, INR) and the neutrophil-to-lymphocyte ratio (NLR), an inflammatory marker (3.78 ± 1.67), remained within clinical limits (Tab. 2).

Socio-demographic and obstetric characteristics. In this study, caesarean section indications, obstetric histories, requirements for additional oxytocin and blood transfusion, and basic demographic characteristics were compared between the case and control groups.

Focusing on the most critical findings. When the socio-demographic and obstetric characteristics of the participants were examined, no statistically significant differences were observed between the groups regarding age, height, and body mass index (BMI) ($p>0.05$); however, the mean weight was found to be significantly higher in the control group ($p=0.007$; $p<0.05$). The groups showed a similar distribution in terms of obstetric history data, such as gravidity, parity, and history of abortion, with no statistically significant differences recorded ($p>0.05$). When caesarean indications were evaluated, a significant difference was observed between the groups ($p=0.045$; $p<0.05$), with multi-foetal pregnancies being more prevalent in the control group. Regarding clinical outcomes, the use of carbetocin demonstrated a clear superiority in reducing the need for additional oxytocin and blood transfusions; the requirement for additional oxytocin (4.0%) and blood transfusion (4.0%) in the carbetocin group was found to be significantly lower compared to the control group (30.0% and 26.0%, respectively; $p<0.05$) (Tab. 3).

Table 3. Sociodemographic and Obstetric Characteristics of the Participants

Variable		Case(n=50) (Carbetocin)	Control (Oxytocin)	p
Cesarean Indication	Multifetal Pregnancy	4 (23.5%)	13 (76.5%)	.045
	Macrosomia (Large Infant)	8 (47.1%)	9 (52.9%)	
	Prolonged Labor	7 (87.5%)	1 (12.5%)	
	History of Atony	25 (51.0%)	24 (49.0%)	
	Polyhydramnios	6 (66.7%)	3 (33.3%)	
Gravida	1	12 (24.0%)	9 (18.0%)	.875
	2	12 (24.0%)	17 (34.0%)	
	3	15 (30.0%)	8 (16.0%)	
	≥4	11 (22.0%)	16 (32.0%)	
Parity	0	13 (26.0%)	9 (18.0%)	.788
	1	15 (30.0%)	17 (34.0%)	
	2	15 (30.0%)	13 (26.0%)	
	≥3	7 (14.0%)	11 (22.0%)	
Abortus	0	39 (78.0%)	39 (78.0%)	.445
	1	7 (14.0%)	8 (16.0%)	
	≥2	4 (8.0%)	3 (6.0%)	
Additional Oxytocin	No	48 (96.0%)	35 (70.0%)	.000
	Yes	2 (4.0%)	15 (30.0%)	
Blood Transfusion	No	48 (96.0%)	37 (74.0%)	.002
	Yes	2 (4.0%)	13 (26.0%)	
Age		30.74 ± 5.98	30.24± 5.87	.674
Height		162.80 ± 15.14	162.98± 6.14	.938
Weight		76.10 ± 12.69	84.00± 15.85	.007

When the anthropometric measurements (age, height, weight) of the study group (carbetocin) and the control group (oxytocin) were compared, no statistically significant difference was found between the groups regarding age and

height (p>0.05). However, upon examining the mean weight of the participants, it was determined that the mean weight of the control group (84.00 ± 15.85 kg) was significantly higher compared to the carbetocin group (76.10 ± 12.69 kg) (p=0.007; p<0.05).

Findings on laboratory parameters between groups. A comparative analysis of the preoperative and postoperative biochemical and haematological parameters between the oxytocin and carbetocin groups revealed that both groups were statistically homogeneous in terms of baseline values. No statistically significant differences were found between the groups for any of the laboratory variables examined (Hb, Hct, WBC, PLT, NEU, LYM, INR, ALT, AST, BUN, creatinine, Na, K, and gestational age by ultrasound) (p > 0.05).

Notably, the similarity in haematological and biochemical indicators, such as haemoglobin levels, which were measured at 11.60 ± 1.42 g/dL and 11.73 ± 1.14 g/dL, respectively, confirmed the absence of any systemic differences between the groups. These findings provide a reliable foundation, supporting the conclusion that indicators of uterotonic efficacy, such as blood loss, decrease in haemogram levels, and the need for transfusion, were shaped directly by the pharmacological agents administered, independent of the participants' baseline laboratory values (Tab. 4).

Table 4. Comparison of Laboratory Parameters Between Groups

Variable	Control (Group 1) (n=50) Mean ± SD		Case (Group 2) (n=50) Mean ± SD		p
	Mean	SD	Mean	SD	
USG	38.37	1.53	37.90	1.83	.167
HB	11.60	1.42	11.73	1.14	.598
HTC	35.80	3.46	37.19	9.15	.320
WBC	9.56	2.23	10.27	2.72	.156
PLT	215.42	71.09	238.94	78.95	.121
NEU	6.71	1.83	7.45	2.36	.084
LYM	2.01	.89	1.99	.53	.887
ALT	18.14	35.81	14.06	7.48	.432
AST	20.04	24.00	16.50	8.42	.327
BUN	7.37	2.40	7.64	2.45	.573
CRE	.65	.07	.65	.12	.928
NA	137.18	2.62	136.80	2.42	.453
K	4.03	.29	4.03	.58	.983
INR	1.25	1.36	1.27	1.38	.948
HB	11.60	1.42	11.73	1.14	.167
WBC	9.56	2.23	10.27	2.72	.598
PLT	215.42	71.09	238.94	78.95	.320

Laboratory parameters and caesarean section indications by study groups. Analyses comparing the laboratory parameters of the case and control groups based on caesarean section indications revealed that while general clinical and biochemical data were similar, there were variations based on specific indications. While the mean ages remained similar across both groups, the lowest age was observed in the 'prolonged labour' indication, and the highest body mass index (BMI) values were concentrated in the 'prolonged labour' indication for the case group and the 'macrosomia' (large infant) indication for the control group.

In terms of haematological data, although haemoglobin (Hb) and haematocrit (Hct) levels showed parallelism between the groups, leukocyte (WBC) levels were higher and platelet (PLT) values were lower in the case group. Regarding biochemical parameters, liver enzymes (ALT, AST) were observed to reach their highest levels in the 'macrosomia' indication, whereas renal function tests (BUN, creatinine) and electrolyte levels (Na, K) remained stable, independent of the indications.

In conclusion, it is evaluated that caesarean section indications have a certain differentiating effect on laboratory parameters, and clinical evaluations should be conducted in the light of these specific indications (Tab. 5).

DISCUSSION

Postpartum haemorrhage (PPH) due to uterine atony remains one of the primary determinants of global maternal mortality. Prophylactic uterotonic administration following caesarean section is of vital importance in managing this clinical condition [14]. The current study compared the prophylactic efficacy of carbetocin and oxytocin in patients at high risk for PPH, such as those with multi-foetal gestation, macrosomia, polyhydramnios, and prolonged labour. The findings demonstrated that single-dose carbetocin administration is superior to the standard oxytocin protocol in controlling postoperative haemorrhage, significantly reducing the need for additional uterotonic agents and blood transfusions. These results are consistent with recent literature in which El-Goly et al. (2025) reported that carbetocin more effectively limited blood loss within the first 24 hours postpartum, postoperative haemoglobin declined, and the need for secondary interventions compared to oxytocin [15]. Consequently, the prolonged uterotonic effect and safe haemodynamic profile offered by carbetocin, as emphasized by Goel et al. (2025), make it a more advantageous option than oxytocin for the prevention of PPH in high-risk caesarean deliveries[16].

The data obtained from the current study clearly demonstrate the clinical prophylactic superiority of carbetocin administration in high-risk cesarean cases. While the need for additional uterotonics (oxytocin) in the carbetocin group was found to be as low as 4%, this requirement rose to 30% in the standard oxytocin group (p<0.05), providing evidence of carbetocin's success in primary control. A similar trend was observed in the requirement for blood transfusion: 4% in the carbetocin group versus 26% in the control group (p<0.05). These data indicate that carbetocin not only reduces blood loss but also statistically significantly decreases the need for secondary interventions. These findings are strongly supported by current literature. Munazira et al. (2025) reported that carbetocin significantly reduces total blood loss (p<0.05) and decreases the use of additional uterotonics [17]. The significant difference in the current study regarding transfusion requirements, reinforces carbetocin's success in maintaining haemodynamic stability in high-risk patients.

This superiority of carbetocin is attributable to its pharmacokinetic advantages. Literature emphasizes that the prolonged uterine contraction provided by a single dose of carbetocin is a critical advantage in clinical practice [14]. In the Shanthi study, carbetocin was found to be more effective than oxytocin in the active management of the third stage

Table 5. Statistical Distribution of Laboratory Parameters and Cesarean Indications by Study Groups

	Case					Control				
Variable	1	2	3	4	5	1	2	3	4	5
Age	33.00	28.75	24.43	32.64	31.33	32.69	30.44	24.00	29.00	31.00
BMI	25.00	30.92	32.94	28.07	28.85	28.06	34.55	27.55	32.83	30.08
USG	35.90	38.96	40.33	38.21	37.58	38.12	38.31	40.40	37.56	37.50
HB	11.15	12.19	11.91	11.42	11.45	12.06	11.37	11.40	11.86	10.50
HTC	34.15	37.78	36.27	35.26	36.00	37.38	34.94	35.00	38.53	33.07
WBC	10.05	9.65	10.54	9.08	9.92	10.06	12.51	10.20	9.84	7.87
PLT	256.25	201.25	199.00	221.92	199.17	226.46	243.11	246.00	246.62	216.67
NEU	6.71	6.87	7.66	6.38	6.77	7.41	9.52	7.27	6.91	5.79
LYM	2.42	2.02	2.01	1.80	2.56	1.85	2.13	2.27	2.06	1.46
NLR	2.94	3.48	3.94	3.70	3.14	4.59	4.63	3.20	3.46	4.04
ALT	11.50	41.38	12.71	14.80	11.83	15.15	10.00	6.00	15.71	11.00
AST	16.00	36.13	14.29	17.44	18.83	20.54	13.44	16.00	16.21	10.67
BUN	7.50	8.05	5.70	7.53	7.67	6.69	9.11	7.00	7.72	7.00
CRE	0.63	0.62	0.62	0.65	0.69	0.64	0.67	0.60	0.64	0.64
NA	137.00	136.63	139.57	137.16	135.33	136.46	136.89	138.00	137.00	136.00
K	4.11	3.93	4.01	4.08	3.91	3.87	4.12	3.90	4.10	3.97
INR	1.00	1.03	1.10	1.06	2.70	1.78	1.08	1.09	1.08	1.20
HB	10.43	11.23	11.33	10.62	10.87	10.53	9.76	10.70	10.45	9.80
WBC	15.17	14.09	14.80	12.40	12.42	13.61	14.77	13.20	15.08	12.43
PLT	199.00	175.50	166.86	192.96	173.33	193.85	194.00	212.00	214.42	198.33

1: Multifetal Pregnancy. 2: Macrosomia (Large Infant). 3: Prolonged Labor. 4: History of Atony. 5: Polyhydramnios

of labour for reducing postpartum haemorrhage, with the advantages of a single-dose administration and a comparable safety profile [18].

In conclusion, both the data in the current study and existing evidence support the use of carbetocin as a more advantageous and robust prophylactic agent than oxytocin for the prevention of PPH in high-risk caesarean sections, due to its sustained uterotonic effect and safe haemodynamic profile. The results of a retrospective study by Delorme et al., found no significant difference between the two methods, and differ from the current findings [19]. It is likely that this discrepancy stems from differences in study design and population characteristics. Delorme et al.'s study lacked a prospective randomized design and included low-risk cases, whereas the current study focused on a patient group with high risk for atonic PPH, reflecting real-world clinical practice [19]. This suggests that the efficacy of carbetocin becomes more pronounced in high-risk conditions involving uterine overdistension (multi-foetal gestation, polyhydramnios, large foetus).

Consistent with the literature, carbetocin is an effective agent that significantly reduces early postpartum blood loss and the need for additional uterotonics and transfusions following caesarean section [20]. However, in the current study, postoperative laboratory parameters (Hb, Hct, WBC, PLT) were found to be similar in both groups. These seemingly statistically similar values could be interpreted as equivalent safety profiles for the drugs, yet they may not fully reflect the clinical picture. The significantly higher transfusion rate in the oxytocin group raises the possibility that haemoglobin values in these patients were 'artificially preserved' via transfusion. It is projected that had these transfusion interventions not been performed, the haemoglobin decline in the oxytocin group would have been clinically much more pronounced, revealing a significant difference between the groups.

Despite the randomization process, it is an important finding that the rate of multi-foetal gestation (26% vs. 8%, $p=0.045$; $p<0.05$) and mean maternal weight (84.0 kg vs. 76.1 kg, $p=0.007$; $p<0.05$) were significantly higher in the carbetocin group. It is well-documented in the literature that high Body Mass Index (BMI) and uterine distension increase the risk of atonic haemorrhage [21, 22]. Despite these data, the higher clinical success in the carbetocin group reinforces the potency of the drug in high-risk populations.

Clinical implications. Based on the findings of the current study, the use of prophylactic carbetocin should be considered a priority strategy in clinical practice for preventing PPH in high-risk caesarean deliveries. Specifically in high-risk patients those with multi-foetal gestation, macrosomia, prolonged labour, polyhydramnios, and a history of atony, single-dose (100 μg) carbetocin administration emerges as a more effective option than the standard oxytocin protocol in maintaining uterine contraction and reducing the need for additional uterotonic drugs. Through this pharmacological advantage, the need for invasive interventions, such as blood transfusion in the postoperative period, is reduced, and the clinical workload is optimized. Although laboratory parameters yielded similar results in both groups, the sustained uterotonic effect and safe haemodynamic profile offered by carbetocin provide a critical clinical advantage in enhancing the quality of postoperative care, particularly in high-risk patient populations.

Limitations of the study. The study has certain limitations. First, the sample size (n=50 for each group) is relatively limited, and the study was conducted at a single centre. Second, an imbalance in some risk factors occurred post-randomization; future studies using block randomization or stratification could prevent this bias. Third, the study has a non-blinded design, which may have led to observer bias in clinician behaviour. Finally, the amount of blood loss was measured via clinical indicators (need for additional medication/transfusion) rather than volumetrically. Future multi-centre, placebo-controlled, double-blind studies based on quantitative blood loss measurement will enable the generalization of the obtained results to broader populations.

In conclusion, the use of carbetocin in high-risk caesarean cases provides more effective uterotonic prophylaxis than the standard oxytocin protocol, and significantly reduces the need for invasive interventions such as blood transfusion.

CONCLUSIONS

Based on the results of this clinical trial, the administration of a single prophylactic dose of carbetocin following caesarean section is statistically and clinically significantly more effective than the traditional oxytocin infusion protocol in maintaining uterine muscle tone, and preventing the need for postoperative additional uterotonics.

While no significant difference was observed between the two groups regarding changes in haematological parameters, a statistically significant reduction in the frequency of blood transfusions was observed in the carbetocin group compared to the control group. Consequently, carbetocin is an effective agent that can be safely administered, particularly in patient groups at high risk for postpartum haemorrhage, such as those with multiple gestations and a history of atony. Furthermore, it facilitates patient-side monitoring and enhances the quality of postoperative care.

In light of the findings obtained from the study, the following recommendations are indicated for clinical practice:

- **Prophylactic strategy.** To prevent postpartum haemorrhage in high-risk caesarean deliveries, the use of a single dose (100 μg) of carbetocin should be considered a priority strategy rather than routine oxytocin infusion.
- **Clinical workload optimization.** The prolonged uterotonic effect provided by carbetocin minimises the need for additional medication and transfusions, thereby reducing the clinical workload and ensuring a more efficient use of hospital resources.
- **Laboratory monitoring.** The similarity of haematological parameters between the groups indicates that the safety profile of carbetocin is equivalent to that of oxytocin; nevertheless, careful perioperative laboratory monitoring should be maintained as a standard practice in high-risk cases.
- **Future studies.** To validate these findings in larger populations, the conduct of multi-centre, double-blind, randomized, placebo-controlled studies based on volumetric blood loss measurement will provide significant contributions to the literature

Abbreviations

ALT – Alanine Aminotransferase
AST – Aspartate Aminotransferase
BMI – Body Mass Index
BUN – Blood Urea Nitrogen
CRE – Creatinine
Hb – Haemoglobin
Hct – Haematocrit
INR – International Normalized Ratio
NLR – Neutrophil-to-Lymphocyte Ratio -
PLT – Platelet
PPH – Postpartum Hemorrhage
WBC – White Blood Cell (Leukocyte)

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