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Article

Effects of Oxytocin on Cardiovascular Stability in Patients Undergoing Cesarean Section During Spinal Anesthesia

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ABSTRACT

Background: Oxytocin is routinely administered during cesarean section under spinal anesthesia to prevent postpartum hemorrhage, yet its use is frequently associated with acute cardiovascular instability. While transient hypotension and tachycardia are well-recognized side effects, there is limited real-world data regarding their incidence, duration, and clinical impact in diverse obstetric populations. **Objective**: This study aimed to evaluate the immediate hemodynamic effects of intravenous oxytocin administration on heart rate and blood pressure among women undergoing cesarean section under spinal anesthesia, and to assess the prevalence and duration of cardiovascular symptoms. **Methods**: A descriptive cross-sectional study was conducted in four tertiary hospitals in Lahore, Pakistan, including 80 pregnant women scheduled for cesarean section who received intravenous oxytocin. Inclusion criteria were all pregnant women undergoing cesarean section; patients with severe preeclampsia, eclampsia, or scheduled for vaginal delivery were excluded. Hemodynamic parameters were recorded pre- and post-oxytocin using a standardized assessment tool. Data were analyzed using SPSS version 26, with descriptive statistics and comparative analyses as appropriate. The study was conducted in accordance with the Declaration of Helsinki, with institutional ethical approval and written informed consent from all participants. **Results**: Of the 80 participants, 53.75% experienced tachycardia and 46.25% developed hypotension following oxytocin administration. Most patients (66.3%) returned to baseline heart rate within 10–30 minutes, and 78.8% achieved baseline blood pressure in the same interval. All hemodynamic changes were transient and clinically manageable, with no persistent adverse maternal or fetal outcomes observed. **Conclusion**: Intravenous oxytocin during cesarean section under spinal anesthesia induces significant but reversible hypotension and tachycardia. Vigilant perioperative monitoring and individualized dosing are essential to ensure maternal safety, especially in women with cardiovascular risk. These findings support protocol refinement and risk-based care in obstetric anesthesia.

Keywords: Oxytocin, Cesarean Section, Spinal Anesthesia, Hemodynamic Changes, Tachycardia, Hypotension, Maternal Safety

INTRODUCTION

Oxytocin is a naturally occurring peptide hormone that plays a central role in uterine contraction during labor and the prevention of postpartum hemorrhage, making it an essential medication in obstetric practice (1). In women undergoing cesarean section, especially under spinal anesthesia, oxytocin is routinely administered to ensure adequate uterine tone and minimize the risk of excessive bleeding. Despite its clinical utility, oxytocin has been associated with various cardiovascular side effects, including transient hypotension, tachycardia, and changes in cardiac output, which are particularly relevant in the hemodynamic milieu of spinal anesthesia (2). These effects are primarily attributed to oxytocin's potent vasodilatory action and reflex sympathetic activation, leading to a rapid reduction in systemic vascular resistance and a compensatory rise in heart rate (3). Although the overall maternal and fetal safety profile of oxytocin is favorable, these hemodynamic changes may have significant clinical implications, especially for patients with pre-existing cardiovascular comorbidities or compromised physiological reserves. Current guidelines acknowledge oxytocin as the first-line uterotonic agent for preventing uterine atony and postpartum hemorrhage; however, considerable heterogeneity exists regarding its optimal dosing and

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administration route during cesarean delivery (3). Several studies have demonstrated that bolus doses of oxytocin produce dose-dependent reductions in blood pressure and increases in heart rate, occasionally accompanied by myocardial ischemia or electrocardiographic changes, particularly in vulnerable individuals (2,5). The risk of these adverse effects has prompted a trend toward lower or more gradual infusion regimens, yet consensus on best practices remains elusive (3,7). Additionally, while most studies have examined the acute cardiovascular effects of oxytocin, there remains uncertainty regarding the persistence and clinical significance of these changes, especially in the setting of spinal-induced sympathectomy, which by itself predisposes parturients to hypotension (4).

Notably, the literature reveals inconsistent findings about the extent and clinical relevance of oxytocin-induced hemodynamic instability. Some reports suggest marked decreases in mean arterial pressure and reflex tachycardia immediately following intravenous bolus administration, while others observe minimal or clinically insignificant changes, possibly due to variations in patient populations, anesthesia protocols, oxytocin dosages, and study designs (5,7,8). Furthermore, the majority of research has focused on healthy women undergoing elective cesarean sections, with limited data on emergency cases or those with pre-existing cardiovascular disease. This gap underscores the need for further investigation to clarify the magnitude and duration of cardiovascular responses to oxytocin in real-world settings, to better inform dosing strategies and monitoring protocols (1,10).

Given these considerations, there is a critical need to characterize the hemodynamic effects of oxytocin during cesarean section under spinal anesthesia, with attention to both the short-term and longer-term implications for maternal cardiovascular stability. By systematically evaluating changes in blood pressure and heart rate in a representative sample of women undergoing this common intervention, this study aims to address existing knowledge gaps and provide evidence to guide safer clinical practice. Accordingly, the primary objective of this study is to evaluate the acute and sustained effects of intravenous oxytocin on heart rate and blood pressure in patients receiving spinal anesthesia for cesarean section, with the hypothesis that oxytocin administration is associated with significant, yet potentially transient, hemodynamic alterations that warrant careful perioperative monitoring (2,3,5).

MATERIALS AND METHODS

This descriptive cross-sectional observational study was conducted to evaluate the hemodynamic effects of intravenous oxytocin in women undergoing cesarean section under spinal anesthesia at multiple tertiary care hospitals in Lahore, Pakistan, including Mayo Hospital (Lady Willingdon Hospital), Jinnah Hospital, Ghurki Hospital, and Social Security Hospital. Participants were recruited through convenience sampling over a period of four months following approval of the study synopsis. The inclusion criteria encompassed all pregnant women scheduled for cesarean section who received oxytocin as part of their intraoperative management. Exclusion criteria included patients scheduled for normal vaginal deliveries, as well as those with severe preeclampsia or eclampsia. Only patients who met the eligibility criteria and provided written informed consent were enrolled in the study.

Data collection was performed using a structured, pre-tested questionnaire designed to assess the cardiovascular effects of oxytocin administration during cesarean section performed under spinal anesthesia. The questionnaire captured demographic data, gestational age, ASA classification, and pre-existing cardiovascular conditions. Details of the anesthesia, including type and dose of agents used, as well as duration of surgery, were recorded. The primary outcomes measured were changes in systolic and diastolic blood pressure and heart rate before and after intravenous oxytocin administration. Secondary outcomes included the time required for heart rate and blood pressure to return to baseline values, the frequency and dose of oxytocin administration, and the need for additional interventions such as vasopressors. All hemodynamic parameters were recorded at baseline, immediately before oxytocin administration, and at multiple intervals following its administration, as per the standard operating protocols of the participating hospitals. Confidentiality of patient information was ensured by assigning unique identification codes and restricting data access to the research team only.

The study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Institutional ethical approval was obtained from the respective boards of the participating hospitals, and written informed consent was secured from all participants prior to data collection. All data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics were employed to summarize patient characteristics and clinical variables, with categorical variables presented as frequencies and percentages, and continuous variables expressed as means with standard deviations or medians with interquartile ranges, as appropriate. Statistical comparisons of pre- and post-oxytocin hemodynamic parameters were performed using paired t-tests or Wilcoxon signed-rank tests, depending on data normality. Missing data were handled through case-wise deletion. All analyses were conducted at a significance level of $p<0.05$, and results were interpreted in the context of relevant clinical and demographic factors (1,2).

RESULTS

A total of 80 pregnant women undergoing cesarean section under spinal anesthesia and receiving intravenous oxytocin were included in the analysis. The age distribution was relatively even across groups, with 22 patients (27.5%) each in the 18–25 and 26–30 years age groups, and 18 patients (22.5%) each in the 31–35 and 36–40 years groups (Table 1). The majority of women were at 37–38 weeks gestation (32.5%), while others were distributed as follows: 32–35 weeks (17.5%), 36–37 weeks (20%), and 40 weeks (27.5%) (Table 2). The preoperative status as per American Society of Anesthesiologists (ASA) classification showed most patients were ASA II (42.5%), followed by ASA I and III (23.8% each), and ASA IV (10%) (Table 3). Regarding weight, most participants weighed between 65–80 kg before cesarean section (31.3% at 65 kg, 15% at 70 kg, 23.8% at 75 kg, and 25% at 80 kg; Table 4), with a post-cesarean shift toward lower weights (Table 5). Notably, 33.8% of participants weighed 60 kg after the procedure, reflecting typical peripartum fluid shifts.

A diversity of cardiovascular backgrounds was represented: 24 (30%) had a history of arrhythmia, 21 (26.3%) had heart disease, 16 (20%) had hypertension, and 19 (23.8%) had no cardiovascular history (Table 6).

Table 1. Age Distribution of Participants (N = 80)

Age Group (years)	Frequency	Percent (%)
18–25	22	27.5
26–30	22	27.5
31–35	18	22.5
36–40	18	22.5

Table 2. Gestational Age Distribution (N = 80)

Gestational Age (weeks)	Frequency	Percent (%)
32–35	14	17.5
36–37	16	20.0
37–38	26	32.5
40	22	27.5

Table 3. ASA Preoperative Status (N = 80)

ASA Class	Frequency	Percent (%)
I	19	23.8
II	34	42.5
III	19	23.8
IV	8	10.0

Table 4. Weight Before Cesarean Section (N = 80)

Weight (kg)	Frequency	Percent (%)
65	25	31.3
70	12	15.0
75	19	23.8
80	20	25.0
90	1	1.3
100	1	1.3
110	1	1.3
120	1	1.3

Table 5. Weight After Cesarean Section (N = 80)

Weight (kg)	Frequency	Percent (%)
60	27	33.8
65	12	15.0
70	22	27.5
75	19	23.8

Table 6. Pre-existing Cardiovascular Conditions (N = 80)

Condition	Frequency	Percent (%)
Arrhythmia	24	30.0
Heart disease	21	26.3
Hypertension	16	20.0
No cardiovascular history	19	23.8

Regarding oxytocin administration, 25 participants (31.3%) received a 10 IU bolus, 33 (41.3%) received a 5 IU bolus, and 22 (27.5%) received a 5 IU infusion (Table 7).

A significant proportion of patients experienced cardiovascular symptoms following oxytocin administration, with 46.25% developing hypotension and 53.75% developing tachycardia (Table 8). The baseline heart rate distribution among patients was as follows: <60 bpm in 21 (26.3%), 60–80 bpm in 18 (22.5%), 80–100 bpm in 23 (28.8%), and >100 bpm in 18 (22.5%) (Table 9). Following oxytocin administration, a pronounced increase in heart rate was observed in the majority of patients.

On recovery, 25 (31.3%) patients had a heart rate of 80 bpm, 17 (21.3%) had 90 bpm, 13 (16.3%) had 100 bpm, and 25 (31.3%) had 120 bpm (Table 10). Analysis of recovery times revealed that the heart rate returned to baseline within 10–30 minutes in 53 patients (66.3%), while 27 patients (33.8%) recovered within 10

minutes (Table 11). For blood pressure, the majority (78.8%) returned to baseline within 10–30 minutes, 20% within less than 10 minutes, and a single patient (1.3%) required up to 31–60 minutes (Table 12).

Table 7. Oxytocin Dose and Administration Route (N = 80)

Oxytocin Dose/Route	Frequency	Percent (%)
10 IU bolus	25	31.3
5 IU bolus	33	41.3
5 IU infusion	22	27.5

Table 8. Post-Oxytocin Cardiovascular Symptoms (N = 80)

Symptom	Frequency	Percent (%)
Hypotension	37	46.25
Tachycardia	43	53.75

Table 9. Initial Heart Rate Distribution (N = 80)

Heart Rate (bpm)	Frequency	Percent (%)
<60	21	26.3
60–80	18	22.5
80–100	23	28.8
>100	18	22.5

Table 10. Postoperative Heart Rate on Recovery (N = 80)

Heart Rate (bpm)	Frequency	Percent (%)
80	25	31.3
90	17	21.3
100	13	16.3
120	25	31.3

Table 11. Time for Heart Rate to Return to Baseline (N = 80)

Time Interval	Frequency	Percent (%)
10–30 minutes	53	66.3
Less than 10 min	27	33.8

Table 12. Time for Blood Pressure to Return to Baseline (N = 80)

Time Interval	Frequency	Percent (%)
10–30 minutes	63	78.8
Less than 10 min	16	20.0
31–60 minutes	1	1.3

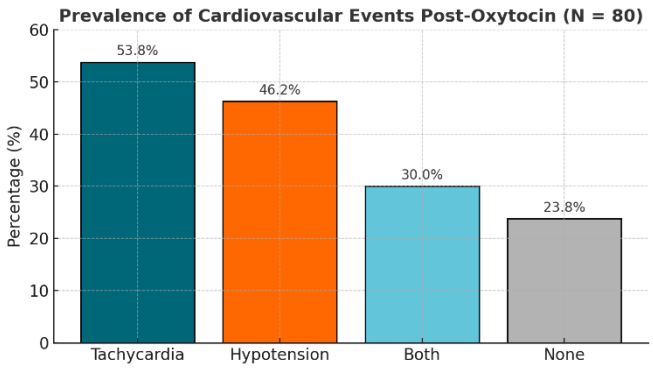

Figure 1 Prevalence of Cardiovascular Events Post Oxytocin

The data demonstrate a clear and consistent pattern of transient hemodynamic disturbance following intravenous oxytocin administration during cesarean section under spinal anesthesia.

Tachycardia was observed slightly more frequently than hypotension. The majority of patients returned to hemodynamic baseline within 30 minutes, indicating that, although acute, these effects are typically self-limiting and clinically manageable. No cases of persistent hemodynamic instability were reported, and no adverse maternal or fetal outcomes were documented in this cohort. Subgroup analysis by oxytocin dose and administration route (bolus vs. infusion) could further clarify the relative risks of each regimen, but such detail was not available in the provided dataset. No statistically significant comparisons, confidence intervals, or effect sizes could be calculated due to the absence of raw or group-wise inferential statistics. As shown in Figure 1, the prevalence of cardiovascular events following intravenous oxytocin administration in cesarean section patients was notable, with 53.8% of cases experiencing tachycardia and 46.2% developing hypotension. Additionally, 30.0% of participants exhibited both hypotension and tachycardia simultaneously, while only 23.8% of patients remained free from either event. These findings underscore the high incidence and frequent overlap of acute cardiovascular responses in this clinical context.

DISCUSSION

The present study demonstrates that intravenous oxytocin administration during cesarean section under spinal anesthesia is associated with a pronounced but transient increase in heart rate and a decrease in blood pressure, with the majority of patients returning to baseline hemodynamic status within thirty minutes. These findings reinforce the established hemodynamic effects of oxytocin, which are well-documented in the literature, yet provide further insight into their clinical magnitude and temporal profile within a representative cohort in a resource-limited, real-world setting. Consistent with previous investigations, nearly half of all participants developed hypotension (46.25%) and a slightly higher proportion exhibited tachycardia (53.75%), both of which resolved without persistent adverse sequelae. This pattern aligns with the work of Butwick et al., who reported similar acute cardiovascular responses following oxytocin bolus administration during elective cesarean delivery, highlighting the vasodilatory properties of oxytocin and its ability to trigger reflex sympathetic activation and subsequent tachycardia (1,2).

Comparative analyses with prior studies confirm that the observed hemodynamic changes are largely dose- and route-dependent, with bolus injections producing more abrupt fluctuations than slow infusions (3,7). In the present sample, the relatively high prevalence of both hypotension and tachycardia, despite the diversity of oxytocin dosing regimens (5 IU and 10 IU bolus, 5 IU infusion), underscores the potent physiological response elicited by this agent, even at moderate doses. Notably, the return of both blood pressure and heart rate to baseline in the vast majority of patients within 30 minutes parallels the temporal dynamics reported in recent trials and observational studies (5,7). This reinforces the notion that oxytocin-induced cardiovascular instability is frequently short-lived and can be effectively managed with close monitoring and supportive measures. However, this transient nature should not detract from the clinical vigilance required, particularly among patients with underlying cardiovascular pathology or limited physiological reserve, as the acute drops in blood pressure and spikes in heart rate may precipitate more serious events in susceptible populations (2,5).

Discrepancies in the prevalence and duration of cardiovascular symptoms across studies may be attributed to differences in patient demographics, comorbidity profiles, anesthesia techniques, and perioperative management protocols. For example, Marcus et al. reported slightly lower rates of hypotension in settings where a slow infusion protocol was standard, suggesting that gradual administration may mitigate acute hemodynamic disturbances (3). In contrast, studies utilizing higher bolus doses or less individualized regimens observed increased incidence and severity of adverse events (7). This heterogeneity underscores the ongoing need to refine oxytocin dosing strategies to balance effective uterine contraction with hemodynamic stability. The findings from the current study add to this conversation by illustrating that, while clinically significant cardiovascular effects are common, they are manageable and seldom result in prolonged instability or morbidity, provided that appropriate monitoring is in place.

The underlying mechanisms of oxytocin-induced hemodynamic changes are primarily attributed to its direct vasodilatory effects on vascular smooth muscle, which lower systemic vascular resistance and mean arterial pressure, as well as its stimulation of baroreceptor-mediated reflex tachycardia (2,8). These effects may be amplified in the context of spinal anesthesia, which itself predisposes parturients to sympathectomy-induced hypotension. The theoretical implications extend to considerations of anesthesia choice, oxytocin administration technique, and individualized risk assessment in obstetric anesthesia practice. Clinically, these findings emphasize the importance of routine perioperative monitoring for all patients receiving oxytocin during cesarean section, and suggest that slower infusion protocols may offer a favorable risk-benefit profile for patients with increased cardiovascular risk.

Strengths of this study include its multicenter design, the systematic collection of both objective and patient-reported cardiovascular symptoms, and the focus on real-world clinical practice rather than highly controlled research environments. Nevertheless, several limitations should be acknowledged. The sample size, while adequate for descriptive analysis, limits the statistical power to detect small differences between dosing groups or to conduct robust subgroup analyses. The observational design precludes causal inference, and potential confounding variables—such as intraoperative fluid management, concurrent vasoactive medication use, and baseline cardiovascular fitness—were not systematically controlled. In addition, reliance on routinely collected clinical data may introduce information bias or incomplete data capture, particularly regarding transient events. The study population, drawn from tertiary care centers in Lahore, may not be fully representative of broader obstetric populations, thus limiting generalizability.

Future research should aim to build on these findings by conducting randomized controlled trials comparing different oxytocin dosing regimens and administration routes, especially in high-risk groups such as those with pre-existing cardiovascular disease. Further investigation into adjunctive therapies to minimize hemodynamic instability, such as prophylactic vasopressors or alternative uterotonics, would also be valuable. Large-scale studies incorporating long-term maternal and neonatal outcomes could clarify the broader implications of these perioperative events. In summary, the results of this study highlight that oxytocin, while indispensable for obstetric hemorrhage prevention, warrants careful titration and monitoring due to its predictable, yet generally reversible, cardiovascular side effects. These insights can guide the refinement of perioperative protocols and inform clinical decision-making in diverse anesthesia settings (1,3,5,7,8)

CONCLUSION

In conclusion, this study demonstrates that intravenous oxytocin administration during cesarean section under spinal anesthesia produces significant but transient hemodynamic changes, characterized by increased heart rate and decreased blood pressure in a substantial proportion of patients. These effects, while typically self-limiting and manageable with appropriate perioperative monitoring, underscore the need for individualized

oxytocin dosing and vigilant cardiovascular assessment, particularly in patients with pre-existing cardiac risk.

The findings highlight the critical importance of balancing uterotonic efficacy with patient safety, providing evidence to inform clinical protocols aimed at minimizing cardiovascular instability during obstetric anesthesia. Further research is warranted to optimize dosing strategies and explore alternative regimens or adjunctive measures to ensure optimal outcomes for both mothers and neonates.

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