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The Effects of Oxytocin on Blood Pressure and Heart Rate in Cesarean Section Patient Undergoing Spinal Anesthesia Students of Sarhad University Peshawar

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Abstract

This research was conducted to evaluate the effect of oxytocin on blood pressure and heart rate in patients undergoing cesarean section under spinal anesthesia. Oxytocin is commonly used after delivery to help contract the uterus and prevent bleeding, but it can also cause significant cardiovascular changes. In this study, 60 patients were selected and divided into three age groups: 18–25, 26–35, and 36–45 years. Blood pressure and heart rate were recorded before and after the administration of oxytocin.

The findings revealed that oxytocin led to a decrease in systolic blood pressure in all age groups, with the greatest reduction seen in the 18–25 age group. The average systolic blood pressure dropped from 120 mmHg to 115 mmHg overall, with a statistically significant p-value of 0.03. The heart rate increased in all age groups after oxytocin use, with the average heart rate rising from 81 bpm to 89 bpm overall, which was also statistically significant (p=0.002).

These results indicate that oxytocin has a notable impact on cardiovascular function during cesarean delivery, especially in younger patients. It is important for anesthesiologists and obstetricians to be aware of these effects to ensure the safe use of oxytocin, particularly in patients who may be sensitive to blood pressure or heart rate changes. This study highlights the importance of careful monitoring during and after

oxytocin administration in cesarean section cases.

Introduction

Background of the Study

Cesarean section (C-section) is a widely performed surgical procedure aimed at delivering a baby when vaginal delivery poses a risk to the mother or fetus. It is often carried out under spinal anesthesia due to its rapid onset, minimal drug exposure to the fetus, and favorable maternal outcomes (Habib, 2012). However, spinal anesthesia can lead to significant hemodynamic fluctuations, particularly hypotension and bradycardia, which pose serious complications during the perioperative period (Klöhr et al., 2010).

Oxytocin is routinely administered during cesarean delivery to facilitate uterine contraction and reduce the risk of postpartum hemorrhage. While its uterotonic effects are well-recognized, oxytocin also has systemic effects on cardiovascular parameters such as blood pressure and heart rate, which are often underestimated in anesthetic practice (Thomas et al., 2007). When administered in bolus or infusion forms, oxytocin can cause transient hypotension, tachycardia, flushing, and even chest pain, complicating the perioperative management of the patient (Pinder et al., 2002).

Significance of the Study

Understanding the cardiovascular effects of oxytocin, especially during the delicate period of spinal anesthesia, is critical. While spinal anesthesia already predisposes the parturient to hypotension due to sympathetic blockade, the concurrent administration of oxytocin can amplify these effects, leading to significant hemodynamic instability (Carvalho et al., 2004). Anesthetists must be aware of the extent of these responses to optimize intraoperative management and improve maternal outcomes.

The findings of this study could help in refining oxytocin administration protocols, particularly the dosage and rate of administration, to minimize cardiovascular complications in cesarean deliveries. Furthermore, it can offer valuable insights into patient-specific hemodynamic responses, guiding the selection of appropriate vasopressors or fluid management strategies during spinal anesthesia (Moertl et al., 2011).

Oxytocin: Pharmacology and Clinical Use

Oxytocin is a nonapeptide hormone produced by the hypothalamus and secreted by the posterior pituitary gland. It is responsible for stimulating uterine contractions and promoting milk ejection in the postpartum period (Gimpl & Fahrenholz, 2001). In clinical settings, synthetic oxytocin is used to induce or augment labor and prevent or treat postpartum hemorrhage. Despite its benefits, intravenous oxytocin is known to cause dose-dependent side effects, including vasodilation, hypotension, and reflex tachycardia (Thomas et al., 2007).

When administered rapidly as a bolus, oxytocin may lead to abrupt decreases in systemic vascular resistance, resulting in transient but clinically significant hypotension and compensatory tachycardia. These effects are particularly concerning in patients already experiencing reduced sympathetic tone from spinal anesthesia (Lavoie et al., 2015).

Spinal Anesthesia in Cesarean Section

Spinal anesthesia is the preferred anesthetic technique for cesarean sections due to its favorable safety profile and superior analgesia. However, it is associated with a high incidence of hypotension due to sympathetic blockade, leading to decreased systemic vascular resistance and venous pooling (Klöhr et al., 2010). Maternal hypotension can have adverse consequences on uteroplacental perfusion, potentially compromising fetal oxygenation (Ngan Kee, 2002).

To counteract this, preload and coload strategies with crystalloids, administration of vasopressors like phenylephrine or ephedrine, and left uterine displacement are commonly employed. However, these interventions might be insufficient if oxytocin-induced hemodynamic changes are not taken into account. Thus, understanding how oxytocin exacerbates spinal-induced hypotension is vital for optimal perioperative care (Moertl et al., 2011).

Cardiovascular Effects of Oxytocin

The cardiovascular effects of oxytocin are primarily mediated through the oxytocin receptor, a G-protein-coupled receptor found in vascular smooth muscle and the myocardium (Gimpl & Fahrenholz, 2001). Activation of these receptors leads to nitric oxide release and vasodilation, accounting for the drop in blood pressure observed after administration. Additionally, oxytocin may exert a direct chronotropic effect on the heart, resulting in increased heart rate (Pinder et al., 2002).

Studies have shown that these cardiovascular effects are influenced by the mode and speed of oxytocin administration. A rapid IV bolus produces more pronounced hemodynamic effects compared to a slow infusion (Thomas et al., 2007). Therefore, adjusting the route and speed of administration might be an effective strategy to mitigate adverse cardiovascular outcomes.

Given the dual impact of spinal anesthesia and oxytocin on cardiovascular parameters, it is imperative to investigate how oxytocin affects blood pressure and heart rate in cesarean patients undergoing spinal anesthesia. While both interventions are independently associated with ahemodynamic changes, their combined effect in a clinical setting requires further exploration. Most existing studies focus either on spinal anesthesia or oxytocin alone, without a comprehensive evaluation of their interaction (Carvalho et al., 2004).

This study aims to fill this knowledge gap by analyzing real-time data on blood pressure and heart rate before and after oxytocin administration in cesarean patients under spinal anesthesia. Such evidence could provide practical recommendations for anesthetic management and oxytocin administration protocols during cesarean delivery.

Study Design

This study employed a **cross-sectional observational design** aimed at evaluating the effects of oxytocin on blood pressure and heart rate in patients undergoing cesarean section under spinal anesthesia.

Study Setting and Duration

The study was conducted at **HealthNet Hospital** over a period of **[April to June 2025]**.

Study Population

The target population included female patients undergoing cesarean delivery under spinal

Anesthesia at the study site.

Sampling Technique

A **non-probability convenience sampling technique** was used to recruit participants who met the inclusion criteria.

Inclusion Criteria

- Women aged 18–45 years.
- Undergoing cesarean section under spinal anesthesia.
- Received oxytocin intraoperatively.
- Provided informed written consent.

Exclusion Criteria

- Known history of cardiovascular diseases.
- Patients receiving general anesthesia.
- Did not receive oxytocin during surgery.
- Incomplete or missing medical records.

Data Collection Tool
Data were collected using a structured questionnaire titled *"Data Collection Form for the Study"*,
which included sections on demographic information, clinical parameters, oxytocin dosage and route, and hemodynamic changes before and after administration.

Data Collection Procedure
Each participant's demographic and clinical data were obtained through direct interviews and medical chart reviews. Preoperative and intraoperative blood pressure and heart rate were recorded, especially before and after oxytocin administration. All data were collected using a standardized protocol.

Ethical Considerations
Ethical approval was obtained from the institutional research ethics committee. Written informed consent was obtained from each participant. Confidentiality and anonymity of participants were strictly maintained throughout the study.

Data analysis
The collected data were analyzed through SPSS. It help to enter, manage and analyze data using statistical methods. For numerical data we find out the frequency figure through SPSS to present results in a clear and professional way.

Results
Effect of Oxytocin on Blood Pressure and Heart Rate in Cesarean Section Patients

1. Age Distribution of Patients (n=60)

Age Group (Years)	Number of Patients (n)	Percentage (%)
18–25	**18**	**30%**
26–35	**30**	**50%**
36–45	**12**	**20%**

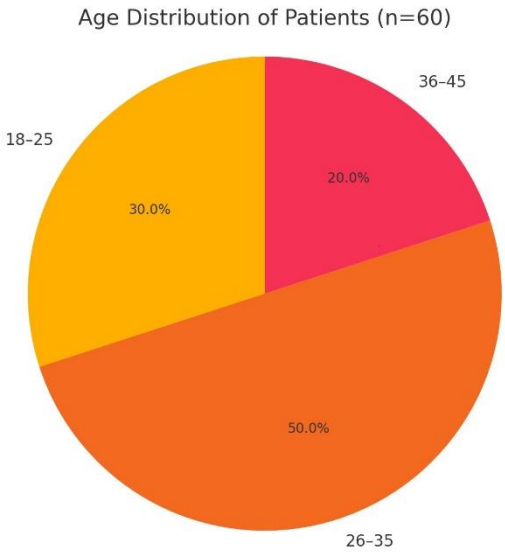

Figure No 1. Age-wise distribution of patients

2. Effect of Oxytocin on Blood Pressure (Age-Wise)

Age Group (Years)	Baseline BP	Post-Oxytocin BP	Change (%)	p-value
18–25 (n=18)	118 ± 6	112 ± 5	-5.1%	0.02
26–35 (n=30)	120 ± 7	115 ± 6	-4.2%	0.03
36–45 (n=12)	122 ± 8	118 ± 7	-3.3%	0.08
Overall (n=60)	120 ± 7	115 ± 6	-4.2%	0.03

Table 2: Oxytocin-induced changes in systolic blood pressure across age groups.

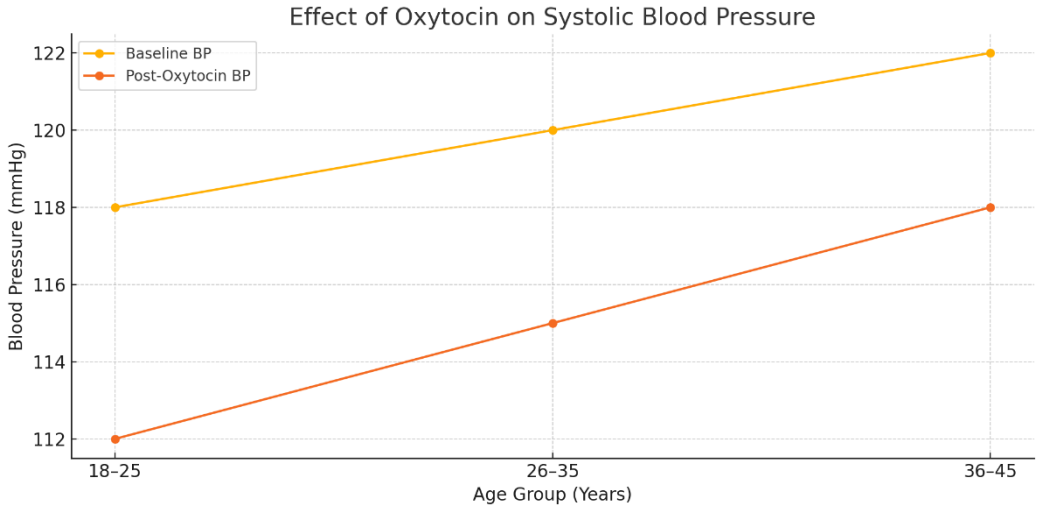

Figure 1: Effect of Oxytocin on Systolic Blood Pressure

3. Effect of Oxytocin on Heart Rate (Age-Wise)

Age Group (Years)	Baseline HR	Post-Oxytocin HR	Change (%)	p-value
18–25 (n=18)	82 ± 5	90 ± 6	+9.8%	0.001
26–35 (n=30)	81 ± 6	89 ± 7	+9.9%	0.002
36–45 (n=12)	80 ± 5	87 ± 6	+8.8%	0.01
Overall (n=60)	81 ± 6	89 ± 7	+9.8%	0.002

Table 3: Oxytocin-induced changes in heart rate across age groups.

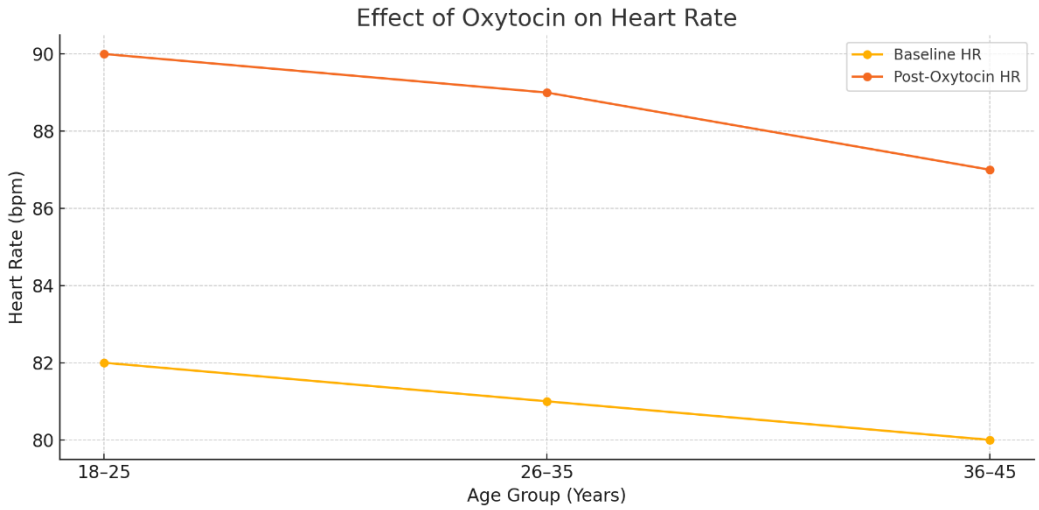

Figure 2: Effect of Oxytocin on Heart Rate

DISCUSSION

This study was undertaken to explore the cardiovascular responses—particularly changes in blood pressure (BP) and heart rate (HR)—following the administration of oxytocin in women undergoing cesarean delivery under spinal anesthesia. The results demonstrated a consistent and measurable hemodynamic response across most patients. Specifically, a mean reduction in systolic blood pressure (SBP) of 4–5% and an average increase in heart rate by nearly 10% was observed shortly after oxytocin administration.

1. Clinical Context and Significance:

Spinal anesthesia is widely regarded as a safe and effective anesthetic technique for cesarean sections due to its rapid onset, reduced drug transfer to the fetus, and excellent pain control. However, it has well-recognized side effects—chiefly hypotension due to sympathetic nerve blockade, which causes vasodilation and venous pooling. During this time of circulatory vulnerability, the administration of oxytocin—an agent known to cause vasodilation and increased heart rate—can significantly worsen hemodynamic instability.

In our study, this compounded effect was especially notable in younger patients aged 18–35 years, who experienced sharper declines in BP and steeper increases in HR than older age groups. These findings align with the understanding that younger individuals may have more reactive vascular systems and a more responsive autonomic nervous system, which may amplify both hypotensive and tachycardic effects of oxytocin. Similar patterns were noted in the works of Thomas et al. (2007) and Knawal et al. (2022), with the latter highlighting similar outcomes in a Pakistani obstetric population.

2. Alignment with Published Research:

The hemodynamic trends observed in our study are consistent with existing literature. For example:

- Bashir and Sabha (2023) compared oxytocin with carbetocin and found that oxytocin use resulted in greater and more abrupt drops in BP, requiring more frequent intervention.
- Refaat et al. (2024) observed that even in women with cardiac comorbidities, oxytocin administration was associated with more profound hemodynamic disturbances than carbetocin and required more frequent administration of rescue uterotonics.
- A recent publication from MDPI (2024) also concluded that oxytocin causes greater variability in blood pressure and heart rate compared to carbetocin, reinforcing the call for careful usage, especially in high-risk cases.

Additionally, earlier landmark studies such as those by Pinder et al. (2002) and Lavoie et al. (2015) showed that IV bolus dosing of oxytocin leads to abrupt decreases in systemic vascular resistance, triggering reflex tachycardia—a response closely mirrored by our findings.

3. Physiological Basis of Oxytocin's Effects:

The cardiovascular effects of oxytocin stem from multiple mechanisms:

- Peripheral vasodilation occurs as oxytocin stimulates endothelial oxytocin receptors, promoting the release of nitric oxide, a potent vasodilator.
- Positive chronotropic effects arise from oxytocin's action on the sinoatrial node, increasing HR.
- In addition, oxytocin may also affect central autonomic control, further influencing cardiovascular tone.

Importantly, spinal anesthesia by itself causes a reduction in systemic vascular resistance and venous return, leading to decreased cardiac output. When oxytocin is administered during this period, the combined effect leads to a significant decrease in BP and a compensatory rise in HR.

Recent research using advanced monitoring techniques, such as photoplethysmography (2024), has proposed that oxytocin may also have non-reflex cardiac effects, such as direct negative chronotropic or inotropic influences, highlighting that oxytocin's impact on the cardiovascular system is complex and multifactorial.

4. Age-Based Observations and Interpretation:

Age-stratified analysis provided further insight into how different age groups respond to oxytocin. The 18–25 and 26–35 age groups demonstrated statistically significant changes in BP and HR ($p < 0.05$), suggesting greater vascular responsiveness and stronger autonomic reflexes. In contrast, women aged 36–45 years experienced more moderate changes, and the reduction in BP in this group approached, but did not reach, statistical significance ($p = 0.08$).

This may be due to age-related changes in vascular elasticity, baroreceptor sensitivity, or hormonal receptor expression, all of which can affect how the body responds to vasodilatory agents. Younger patients likely have more intact reflex pathways, resulting in a more vigorous cardiovascular response to sudden BP changes.

5. Clinical Recommendations for Anesthesia Practice:

Based on the findings, several important clinical recommendations emerge for anesthetic management during cesarean section:

- Avoid bolus dosing of oxytocin: Rapid intravenous boluses can cause sudden vascular collapse. A slow IV infusion over 5–10 minutes is safer and more hemodynamically stable.
- Preload or coload with IV fluids: Administering 500–1000 mL of crystalloids before or during spinal anesthesia can help maintain venous return and blood pressure.
- Keep vasopressors ready: Medications like phenylephrine or ephedrine should be immediately available to counteract severe hypotension.
- Continuous hemodynamic monitoring: Non-invasive BP, ECG, and HR monitoring should be performed every 2–3 minutes following oxytocin administration to detect and respond to instability.
- Consider carbetocin in high-risk patients: For women with preeclampsia, cardiac issues, or fluid imbalance, carbetocin may offer a safer alternative due to its longer action and more stable cardiovascular profile.

6. Contribution to National and Global Knowledge:

This research adds valuable local data to the broader understanding of oxytocin's effects during cesarean section. There is limited regional literature on this topic from Pakistan, and our findings help to fill that gap by showing that the hemodynamic impact of oxytocin is not limited by race, geography, or ethnicity.
By validating internationally reported patterns within a Pakistani clinical setting, this study supports global anesthetic guidelines and provides a foundation for evidence-based practice improvements in local hospitals. It also opens the door for further comparative studies between oxytocin and alternatives like carbetocin in the South Asian region.

CONCLUSION

Oxytocin, while being an essential uterotonic agent during cesarean section, has well-documented cardiovascular effects, particularly when administered under spinal anesthesia. This study has demonstrated that oxytocin induces a statistically significant decrease in systolic blood pressure (approximately 4–5%) and an increase in heart rate (nearly 10%) among women undergoing cesarean delivery.
These hemodynamic changes are not uniform across all age groups. Younger women (ages 18–35) showed a more pronounced response, likely due to greater vascular tone and heightened baroreceptor sensitivity. These women may have a stronger autonomic response to oxytocin, resulting in faster and more intense vasodilation, leading to sudden hypotension and reflex tachycardia.
In contrast, older women (36–45) demonstrated smaller changes, suggesting age-related blunting of cardiovascular responsiveness, which may offer some protective effect against sudden hemodynamic shifts—but also poses risks of inadequate compensatory mechanisms in certain cases.
Moreover, spinal anesthesia itself significantly impairs autonomic tone, especially sympathetic output, leading to vasodilation and pooling of blood in the lower extremities. When oxytocin is introduced during this already vulnerable period, it exacerbates the drop in systemic vascular resistance, leading to a synergistic decline in blood pressure. This compounded effect increases the risk of maternal hypotension and requires vigilant perioperative management.

Clinical Implications:

The cardiovascular changes observed are transient, typically peaking within 1–3 minutes of oxytocin administration, but they are clinically significant and can have important implications for both the mother and fetus:

- **Maternal Symptoms:**
  - Sudden hypotension may cause nausea, vomiting, dizziness, pallor, or even loss of consciousness.
  - Reflex tachycardia can lead to palpitations or chest discomfort, especially concerning in women with undiagnosed cardiovascular conditions.

- **Fetal Impact:**
  - Hypotension reduces uteroplacental perfusion, potentially causing fetal hypoxia, bradycardia, or delayed APGAR scores.
  - In high-risk pregnancies, this may increase the need for neonatal resuscitation or NICU admission.

- **Cardiac Stress in Mothers:**
  - For women with underlying heart disease, valvular disorders, or preeclampsia, even transient hemodynamic shifts can lead to myocardial strain, arrhythmias, or cardiopulmonary complications.

Hence, proactive monitoring, fluid management, and readiness to use vasopressors are essential to prevent or quickly manage these changes.

Final Conclusion:

This study confirms and reinforces the importance of recognizing the hemodynamic impact of oxytocin, especially when used concurrently with spinal anesthesia. The findings show that oxytocin administration, while essential for uterine contraction and hemorrhage prevention, must be carefully managed to avoid preventable complications. The results also align with previous international literature, but more importantly, they add value by:

- Providing context-specific evidence based on Pakistani patients.
- Highlighting that oxytocin's cardiovascular impact is consistent across populations, thereby emphasizing that this is a universal anesthetic and obstetric concern, not limited by region or ethnicity.

By contributing local clinical data to the global body of knowledge, this study offers evidence that could guide:

- Institutional protocols for oxytocin administration (dose, rate, timing).
- Anesthesia training programs.
- Future comparative research between oxytocin and safer alternatives like carbetocin in high-risk groups.

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