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ORIGINAL RESEARCH SPINAL ANESTHESIA

Efficacy of dexmedetomidine versus fentanyl as adjuvant to intrathecal bupivacaine in decreasing incidence of post spinal shivering in parturients undergoing cesarean section

Rania Maher Hussien [1], Osama Medhat Ragab Abdelrehem [2], Yassmin Hassan Abd El Sattar [3], Rami Mounir Wahba Gobrane [4]

Author affiliations:

1. Rania Maher Hussien; Associate Professor of Anaesthesia, Intensive Care & Pain Management- Faculty of Medicine, Ain Shams University, Cairo, Egypt; Email: drrania_maamon@med.asu.edu.eg
2. Osama Medhat Ragab Abdelrehem; Resident, Department of Anaesthesia, Intensive Care & Pain Management - Faculty of Medicine, Ain Shams University, Cairo, Egypt; Email: osama.osama.2013.om@gmail.com
3. Yassmin Hassan Abd El Sattar; Lecturer of Anaesthesia, Intensive Care & Pain Management - Faculty of Medicine, Ain Shams University, Cairo, Egypt; Email: yassminhassan7@gmail.com
4. Rami Mounir Wahba Gobrane,; Assistant Professor of Anaesthesia, Intensive Care & Pain Management, Faculty of Medicine, Ain Shams University, Cairo, Egypt; Email: ramiwahba@yahoo.com

Correspondence: Rania Maher Hussien; Email: drrania_maamon@med.asu.edu.eg; Phone: 01000544520

ABSTRACT

Background & objective: Shivering is one of the common troublesome complications following regional anesthesia, which causes much discomfort to the patient, besides its adverse effects on the oxygenation and hemodynamic parameters. It may interfere with pulse oximetry and electrocardiogram monitoring. It can also increase oxygen demand. Various pharmacological and non-pharmacological measures have been used to prevent and/or control shivering. We conducted this study to observe if addition of dexmedetomidine to the spinal bupivacaine for cesarean section will offer better results as compared to fentanyl added to bupivacaine.

Methodology: 130 parturients, scheduled to have spinal anesthesia for cesarean section, were divided into two equal groups; each consisting of 65 patients. Fentanyl group: received 25 µg fentanyl with 12.5 mg hyperbaric bupivacaine 0.5% intrathecally, and Dexmedetomidine group: received 10 µg dexmedetomidine with 12.5 mg hyperbaric bupivacaine 0. 5% intrathecally. The frequency and the intensity of shivering was registered. The time to onset and duration of the sensory as well as motor blocks was noted. Hemodynamic parameters were compared.

Results: Post-spinal shivering was more apparent in the fentanyl group; however, there was no statistical difference between both groups regarding its incidence and intensity. Patients in the dexmedetomidine group had a faster onset and a longer duration of both sensory and motor block compared to the fentanyl group patients. Therefore, time to first rescue analgesic was longer in the dexmedetomidine group. Regarding the hemodynamic parameters dexmedetomidine group showed no statistically significant difference regarding hypotension and a statistically significant difference regarding occurrence of bradycardia compared to fentanyl group.

Conclusion: Both fentanyl and dexmedetomidine, as intrathecal adjuvants to bupivacaine decreased the incidence and the intensity of shivering without any significant difference.

Keywords: Dexmedetomidine; Fentanyl; Intrathecal Bupivacaine; Post Spinal Shivering; Cesarean Section

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1. INTRODUCTION

Spinal anesthesia is considered the preferred anesthetic technique for cesarean sections. Approximately 80% to 90% of cesarean sections are performed under spinal anesthesia. This has resulted in a reduction in maternal mortality, primarily by avoiding the common risks associated with general anesthesia—such as aspiration, difficult intubation, and the potential negative effects of general anesthetics on the fetus.[1]

Shivering is defined as an involuntary, repetitive activity of the skeletal muscles and is frequently observed in patients undergoing surgery. It may result from intraoperative heat loss, increased sympathetic activity, pain, or the systemic release of pyrogens.[2] It is believed that spinal anesthesia impairs the thermoregulatory system by inhibiting tonic vasoconstriction, a key process in maintaining core body temperature. Additionally, spinal anesthesia leads to the redistribution of core heat from the trunk (below the level of the block) to the peripheral tissues. These combined effects increase the risk of hypothermia and, consequently, shivering.

Adjuvant drugs are used in neuraxial anesthesia, some of which have shown efficacy in mitigating side effects, including shivering.[3] Dexmedetomidine, a highly selective α2-adrenoreceptor agonist, offers several benefits as an intrathecal adjuvant. It accelerates anesthesia onset, extends sensory and motor block duration, reduces postoperative pain, and lowers additional analgesia requirements. It also promotes vasodilation, raises the shivering threshold, and suppresses central thermoregulation.[4]

Fentanyl, a synthetic phenylpiperidine derivative opioid, is highly lipophilic and acts as an agonist at μ-opioid receptors. When administered intrathecally, fentanyl produces dose-dependent analgesia by acting on the dorsal horn of the spinal cord to inhibit neurotransmitter release.[5] Low doses of intrathecal fentanyl (10–40 μg) have been found effective in reducing discomfort during and after cesarean section. Moreover, fentanyl has been shown to reduce the incidence and severity of shivering, possibly through its effects on spinal afferent thermal input and thermoregulatory pathways.[6] The objective of this study was to evaluate and compare the effectiveness of intrathecal dexmedetomidine and fentanyl, when used as adjuvants to hyperbaric bupivacaine, in preventing post-spinal shivering.

2. METHODOLOGY

This prospective, randomized clinical trial was conducted after obtaining institutional ethical approval, Informed consent was obtained from every participant or his guardian.

The study enrolled female patients aged 20–34 years, ASA physical status I or II, with a height ≤ 165 cm and Body Mass Index (BMI) ≤ 40 kg/m², scheduled for elective cesarean sections under spinal anesthesia, with expected surgery duration of ≤ 90 min. Exclusion criteria included refusal to participate, ASA status III or IV, spinal abnormalities, neurological or psychiatric disorders, or any of the contraindications to spinal anesthesia.

A total of 130 parturients were randomly assigned to two equal groups (n = 65 each) via sealed opaque envelopes, based on the intrathecal adjuvant received:

- **Group F (Fentanyl):** Received 2.2 mL of 0.5% hyperbaric bupivacaine (Sunnybupivacaine 0.5%, Sunny Pharm) + 0.5 mL (25 μg) fentanyl (Fentanyl Hameln® 0.1 mg/2 mL, Sunny Pharm).[7]
- **Group D (Dexmedetomidine):** Received the same bupivacaine dose + 0.5 mL (10 μg) dexmedetomidine, prepared by diluting 0.1 mL (200 μg/2 mL; Precedex™, Hospira) with 0.4 mL of 0.9% saline.[8]

On arrival in the OR, baseline ECG, MAP, HR, and SpO_2 were recorded. A 500 mL preload of Ringer's lactate was

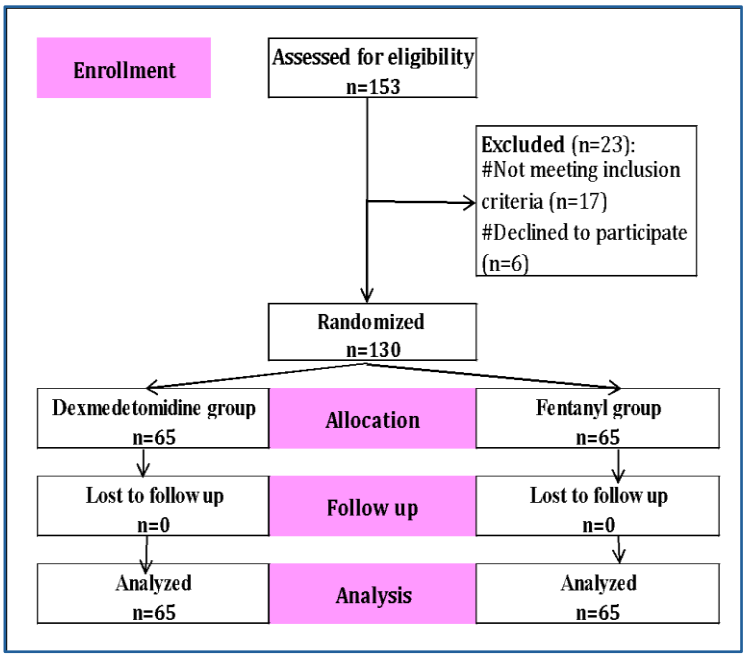

Figure 1: Flow chart of the study

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Table 1: Comparative demographic data in the study groups

Variables		Dexmedetomidine group (Total = 65)	Fentanyl group (Total = 65)	P-value
Age (years)	Mean ± SD	27.6 ± 3.5	28.1 ± 4.1	0.515
	Range	20.0–35.0	20.0–35.0	
Height (cm)	Mean ± SD	158.1 ± 3.7	158.4 ± 3.3	0.670
	Range	150.0–165.0	151.0–165.0	
BMI (kg/m^2)	Mean ± SD	28.3 ± 2.2	28.4 ± 1.9	0.902
	Range	23.9–34.2	24.6–32.8	
ASA (n, %)	I	53 (81.5%)	51 (78.5%)	0.661
	II	12 (18.5%)	14 (21.5%)	
Operation duration (min)	Mean ± SD	68.0 ± 7.8	66.2 ± 8.6	0.207
	Range	52.0–88.0	44.0–89.0	

BMI: Body Mass Index. ASA: America Society of Anesthesiologists. ^Independent t-test. #Chi square test. §Fisher's Exact test; P < 0.05 considered as significant

Table 2: Comparative sensory block data between the studied groups

Variables		Dexmedetomidine group (n = 65)	Fentanyl group (n = 65)	^P-value	Mean difference ± SE (95% CI)
Onset (min)	Mean ± SD	1.4 ± 0.3	2.1 ± 0.4	**< 0.001***	-0.6 ± 0.1
	Range	1.0–2.0	1.3–2.9		-0.7–-0.5
Duration (min)	Mean ± SD	183.8 ± 4.4	142.3 ± 4.5	**< 0.001***	41.6 ± 0.8
	Range	171.0–195.0	132.0–150.0		40.0–43.1

*^Independent t-test. *Significant. SE: Standard error. CI: Confidence interval. Relative effect: Effect in Dexmedetomidine group relative to that in Fentanyl group; P < 0.05 considered as significant*

given IV over 20 min. Spinal anesthesia was administered in the sitting position under aseptic conditions using a 25-gauge spinal needle by an experienced anesthesiologist.

2.1. Sample size:

Calculated using PASS 15 based on prior studies, assuming a medium effect size (Cohen's d = 0.5).[9] A total of 65 patients per group were required to achieve 80% power (α = 0.05) using a two-sided, equal-variance t-test.

2.2. Statistical analysis: Data were analyzed using IBM SPSS v28.0 (IBM Corp., 2021). Quantitative variables were tested for normality (Shapiro-Wilk), presented as mean ± SD (with range), and compared using independent t-test. Qualitative data were reported as frequencies (%) and analyzed using Chi-square or Fisher's exact test. A P-value ≤ 0.05 was considered statistically significant.

3. RESULTS

The groups were comparable with respect to patient characteristics, including age, ASA classification, height, and BMI, as well as operation duration (P > 0.05) (Table 1). Both sensory and motor block onset occurred significantly earlier and duration was prolonged in the dexmedetomidine group (Tables 2 and 3).

Heart rate and mean arterial pressure decreased from baseline to 30 min in both groups, followed by an increase from 1 to 3 hours post-intervention. However, the dexmedetomidine group demonstrated a statistically significant incidence of bradycardia and hypotension at 30 min, 1 hour, and 2 hours (Tables 4 and 5).

Bradycardia was significantly more frequent in the dexmedetomidine group, whereas hypotension was more frequent but did not reach statistical significance. Additionally, nausea, vomiting, and pruritus were significantly less frequent in the dexmedetomidine group (Table 6).

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Table 3: Comparative motor block data between the studied groups

Variables		Dexmedetomidine group (n = 65)	Fentanyl group (n = 65)	^P-value	Relative effect Mean ± SE 95% CI
Onset (min)	Mean ± SD	3.0 ± 0.3	4.2 ± 0.4	**< 0.001***	-1.2 ± 0.1
	Range	2.5–3.6	2.7–4.9		-1.3–-1.1
Duration (min)	Mean ± SD	156.4 ± 4.7	124.0 ± 4.5	**< 0.001***	32.4 ± 0.8
	Range	142.0–168.0	113.0–132.0		30.8–34.0

*^Independent t-test. *Significant. SE: Standard error. CI: Confidence interval. Relative effect: Effect in Dexmedetomidine group relative to that in Fentanyl group; P < 0.05 considered as significant*

Table 4: Comparative heart rates (beat/min) in the studied groups

Variables		Dexmedetomidine group (n = 65)	Fentanyl group (n = 65)	^P-value	Relative effect Mean ± SE 95% CI
Baseline	Mean ± SD	79.1 ± 2.9	78.7 ± 3.0	0.452	0.4 ± 0.5
	Range	73.0–86.0	70.0–85.0		-0.6–1.4
Min-30	Mean ± SD	63.0 ± 3.0	68.5 ± 2.9	**< 0.001***	-5.5 ± 0.5
	Range	57.0–71.0	60.0–74.0		-6.5–-4.5
Hour-1	Mean ± SD	67.8 ± 3.0	71.4 ± 2.9	**< 0.001***	-3.6 ± 0.5
	Range	62.0–76.0	64.0–77.0		-4.6–-2.5
Hour-2	Mean ± SD	74.2 ± 3.2	77.6 ± 3.0	**< 0.001***	-3.4 ± 0.5
	Range	68.0–83.0	69.0–84.0		-4.5–-2.3
Hour-3	Mean ± SD	83.3 ± 3.1	84.2 ± 3.0	0.104	-0.9 ± 0.5
	Range	78.0–89.0	76.0–89.0		-1.9–0.2

*^Independent t-test. *Significant. SE: Standard error. CI: Confidence interval. Relative effect: Effect in Dexmedetomidine group relative to that in Fentanyl group; P < 0.05 considered as significant*

4. DISCUSSION

Shivering is a common side effect of neuraxial anesthesia, causing discomfort in cesarean section patients. Its incidence after regional anesthesia can reach 55% and may be higher in cesarean cases.[10] While hypothermia is the main cause, shivering can occur even in normothermic patients under spinal anesthesia. The exact cause is unclear, but elevated progesterone in pregnancy may lower the shivering threshold. Additionally, spinal anesthesia's sympathetic blockade impairs thermoregulation by causing peripheral vasodilation, redistributing heat internally, and increasing heat loss.[11] Central nervous system changes also raise the sweating threshold and reduce vasoconstriction. Shivering raises oxygen consumption and CO_2 production, increases metabolic rate, worsens postoperative pain, and disrupts patient monitoring, making its prevention and treatment vital.

Dexmedetomidine, a highly selective α2-adrenergic agonist, offers perioperative sympatholysis, sedation, and analgesia without respiratory depression.[12] Intrathecal use increases vasodilation, raises the shivering threshold, and reduces post-spinal shivering by attenuating the hyperadrenergic stress response.[6] Dexmedetomidine reduces shivering during neuraxial anesthesia in cesarean patients without respiratory depression, unlike agents such as meperidine.[13] Intrathecal lipophilic opioids such as fentanyl—a mu-receptor agonist that modulates spinal thermal inputs and thermoregulation—enhance anesthesia quality, shorten block onset, prolong analgesia, reduce local anesthetic dose, and decrease shivering incidence.[7]

Our study showed a higher, but not statistically significant, incidence of shivering in the fentanyl group (12.3%) compared to the dexmedetomidine group (6.2%). The dexmedetomidine group had an earlier onset and longer duration of motor and sensory block, along

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Table 5: Comparative mean arterial pressure (mmHg) in the studied groups.

Variables		Dexmedetomidine group (n = 65)	Fentanyl group (n = 65)	^P-value	Relative effect Mean ± SE 95% CI
Baseline	Mean ± SD	80.1 ± 2.8	79.8 ± 3.0	0.567	0.3 ± 0.5
	Range	74.0–87.0	71.0–86.0		-0.7–1.3
Min-30	Mean ± SD	74.0 ± 3.0	77.6 ± 2.9	**< 0.001***	-3.5 ± 0.5
	Range	68.0–83.0	69.0–83.0		-4.5–-2.5
Hour-1	Mean ± SD	68.9 ± 3.1	72.6 ± 2.9	**< 0.001***	-3.6 ± 0.5
	Range	64.0–78.0	66.0–79.0		-4.7–-2.6
Hour-2	Mean ± SD	75.2 ± 3.3	78.7 ± 3.1	**< 0.001***	-3.5 ± 0.6
	Range	70.0–83.0	70.0–86.0		-4.6–-2.4
Hour-3	Mean ± SD	84.6 ± 3.1	85.4 ± 3.1	0.149	-0.8 ± 0.5
	Range	80.0–91.0	77.0–90.0		-1.9–0.3

*^Independent t-test. *Significant. SE: Standard error. CI: Confidence interval. Relative effect: Effect in Dexmedetomidine group relative to that in Fentanyl group; P < 0.05 considered as significant*

Table 6: Comparative side effects in the studied groups

Side effects	Dexmedetomidine group (n = 65)	Fentanyl group (n = 65)	P-value	Relative effect Relative risk 95% CI
Bradycardia	11 (16.9%)	3 (4.6%)	**#0.024***	3.67 (1.07–12.54)
Hypotension	7 (10.8%)	2 (3.1%)	§0.164	3.50 (0.76–16.22)
Nausea& vomiting	4 (6.2%)	13 (20.0%)	**#0.019***	0.31 (0.11–0.89)
Pruritis	1 (1.5%)	8 (12.3%)	**§0.033***	0.13 (0.02–0.97)

Data presented as number (%). #Chi square test. §Fisher's Exact test. CI: Confidence interval. Relative effect: Effect in Dexmedetomidine group relative to that in Fentanyl group; P < 0.05 considered as significant

with significantly lower heart rates, mean arterial pressures, and reduced nausea, vomiting, and pruritus compared to the fentanyl group. Similar findings were reported elsewhere, with shivering observed in 10% of patients receiving dexmedetomidine versus 56% in controls (P = 0.001).[14] Other studies also found a lower shivering incidence with intrathecal dexmedetomidine plus bupivacaine compared to bupivacaine alone.[15] [16] These findings align with meta-analyses attributing the reduced incidence of shivering to higher dexmedetomidine doses.[13] Additionally, lower shivering occurrence in the dexmedetomidine group compared to fentanyl has been reported, with some studies noting statistically significant differences.[17]

This study demonstrated that dexmedetomidine had a significantly faster onset and longer duration of sensory and motor blocks compared to fentanyl (P < 0.001). Similar findings were reported elsewhere, with both adjuvants prolonging anesthesia compared to controls, though no direct difference between them was found.[18] Other studies confirmed that dexmedetomidine prolongs sensory analgesia more than fentanyl without added adverse effects, while fentanyl improves onset and duration due to its lipophilicity.[19,20]

In our study, mean arterial pressure and heart rate were significantly lower with dexmedetomidine, with higher incidences of hypotension (10.8% vs. 3.1%) and bradycardia (16.9% vs. 4.6%). Nausea, vomiting, and pruritus occurred more frequently with fentanyl.

Bradycardia linked to intrathecal dexmedetomidine is well documented.[21] Despite lower mean arterial pressure and heart rate, adverse effects were manageable and consistent with prior findings.[22] Hypotension with dexmedetomidine may result from sympatholytic effects reducing catecholamines.

Adjuvants like dexmedetomidine and fentanyl enhance spinal anesthesia, reduce local anesthetic needs, and

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maintain cardiovascular function. Unlike opioids, dexmedetomidine reduces opioid use and postoperative nausea and vomiting (PONV), with no increased PONV reported after spinal dexmedetomidine.[23] Pruritus, common with fentanyl, has been reported in up to 60% of cases in previous studies.[24]

Overall, dexmedetomidine shows promise as an effective adjuvant to enhance anesthesia quality and patient comfort during cesarean sections; however, careful patient monitoring is essential to manage potential hemodynamic effects and ensure safety.

5. LIMITATIONS

Our study is limited by its single-centre design, modest sample size, and lack of long-term follow-up or neonatal outcome assessment. Larger, multicentre trials are recommended to validate these findings and evaluate broader clinical implications.

6. CONCLUSION

This study demonstrated that both intrathecal dexmedetomidine and fentanyl, when used as adjuvants to bupivacaine for cesarean section, effectively reduced the incidence and severity of perioperative shivering. Dexmedetomidine provided a faster onset and longer duration of sensory and motor block, along with reduced postoperative opioid requirements, while maintaining a comparable safety profile.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Conflict of interest

All authors declare that there was no conflict of interest.

9. Funding

The study utilized the hospital resources only, and no external or industry funding was involved.

10. Authors' contribution

All authors took equal part in the conduct of the study, literature search, statistical analysis of the data, drafting and editing the manuscript. All authors approved the final draft.

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