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Original Article

EFFECT OF DIFFERENT DOSES OF FENTANYL AS AN ADJUVANT TO HYPERBARIC LEVOBUPIVACAINE IN SPINAL ANAESTHESIA FOR LOWER SEGMENT CAESAREAN SECTION

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ABSTRACT

Objective: To compare the efficacy and safety of 0.5% hyperbaric levobupivacaine alone versus in combination with two different doses of fentanyl (12.5 µg and 25 µg) for spinal anaesthesia in elective LSCS.

Methods: A prospective, randomised, double-blind comparative study was conducted on 150 ASA Grade I–II pregnant females (20–40 years) undergoing elective LSCS at Rajindra Hospital, Patiala. Patients were allocated into three equal groups (n=50 each): Group I received 2 ml (10 mg) of 0.5% hyperbaric levobupivacaine+0.5 ml normal saline; Group II received the same levobupivacaine+12.5 µg fentanyl; Group III received levobupivacaine+25 µg fentanyl. Haemodynamic parameters, sensory and motor block characteristics, sedation level, duration of analgesia, and complications were recorded.

Results: All groups were demographically comparable. Onset of sensory block was significantly faster in Group III (1.66 min) compared to Group II (2.41 min) and Group I (3.90 min) (pandlt; 0.05). Time to maximum sensory level was shortest in Group III. Motor block onset was earliest in Group III. Duration of analgesia was significantly prolonged in Group III (372.8±22.59 min) versus Group II (306±26.34 min) and Group I (220±18.94 min) (p<;0.001). Haemodynamic parameters were stable across all groups. Nausea, vomiting, and pruritus were significantly more frequent in Group III.

Conclusion: Addition of 25 µg fentanyl to 0.5% hyperbaric levobupivacaine for spinal anaesthesia in LSCS provides the fastest sensory and motor block onset and the longest duration of analgesia with acceptable haemodynamic stability. However, the higher dose carries a greater risk of pruritus and nausea/vomiting compared to 12.5 µg fentanyl.

Keywords: Levobupivacaine, Fentanyl, Spinal anaesthesia, LSCS, Intrathecal opioid, Postoperative analgesia

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INTRODUCTION

Spinal anaesthesia is the most widely used regional technique for lower segment caesarean section (LSCS), offering rapid onset, dense neural blockade, reduced aspiration risk, and avoidance of neonatal depression associated with general anaesthesia [1, 2]. It is preferred over general anaesthesia owing to its simplicity, faster recovery, and the ability to keep the mother conscious during delivery [1].roof

Levobupivacaine, the pure S(−) enantiomer of bupivacaine, has emerged as the local anaesthetic of choice for neuraxial blocks. It exhibits significantly reduced cardiotoxicity and neurotoxicity compared with racemic bupivacaine, attributed to its stereoselective interaction with cardiac sodium and potassium channels [3-5]. Its selectivity for sensory fibres at lower concentrations, prolonged duration of action, and favourable safety profile make it particularly well-suited to obstetric regional anaesthesia [3].

Despite the advantages of levobupivacaine alone, intrathecal opioid adjuvants are frequently co-administered to shorten block onset, improve intraoperative analgesia quality, and prolong postoperative pain relief [6]. Fentanyl, a highly lipophilic synthetic opioid 50–100 times more potent than morphine [7, 8] is the most commonly employed adjuvant in this setting. Published intrathecal fentanyl doses for caesarean section range from 2.5 µg to 50 µg; doses of 12.5 µg and 25 µg represent the lower and upper ends of routine clinical practice [6].

Several studies have evaluated levobupivacaine combined with fentanyl for LSCS and other surgeries [9-15] yet a direct comparison of two clinically relevant fentanyl doses (12.5 µg vs 25 µg) alongside a plain levobupivacaine control in a large obstetric cohort remains limited. The present study was therefore designed to compare these three intrathecal combinations in patients undergoing elective LSCS.

MATERIALS AND METHODS

Study design and ethical approval

A prospective, randomised, double-blind, controlled study was conducted at the Department of Anaesthesiology and Intensive Care, Government Medical College and Rajindra Hospital, Patiala, after obtaining clearance from the Institutional Ethics Committee and written informed consent from all participants.

Participants

One hundred and fifty ASA Physical Status Grade I–II pregnant females aged 20–40 y scheduled for elective LSCS under spinal anaesthesia were enrolled. Patients were excluded if they had ASA Grade III/IV, age<20, >40 y, coagulation defects, neurological disorders, valvular heart disease, skin infection at the puncture site, a history of allergy to the study drugs, or any adverse obstetric history.

Randomisation and blinding

Patients were randomly allocated into three groups of 50 using computer-generated random tables:

Group I: 2.0 ml (10 mg) 0.5% hyperbaric levobupivacaine+0.5 ml normal saline (total volume 2.5 ml)

Group II: 2.0 ml (10 mg) 0.5% hyperbaric levobupivacaine+12.5 µg fentanyl in 0.5 ml (total 2.5 ml)

Group III: 2.0 ml (10 mg) 0.5% hyperbaric levobupivacaine+25 µg fentanyl in 0.5 ml (total 2.5 ml)

The anaesthesiologist preparing the syringe was not involved in outcome assessment, thus ensuring observer blinding.

Levobupivacaine was selected as the local anaesthetic based on its well-established safety advantage over racemic bupivacaine, particularly its reduced cardiotoxicity and neurotoxicity. Fentanyl was chosen as the opioid adjuvant given its high lipophilicity, rapid onset, and proven efficacy in enhancing intrathecal block quality [8].

Anaesthetic technique

Standard pre-operative fasting protocols were followed. Tablet rabeprazole 20 mg was administered on the morning of surgery. In

the operating room, routine monitors (ECG, non-invasive blood pressure, pulse oximetry) were attached. Intravenous access was established with an 18-G cannula and patients were preloaded with 15 ml/kg of Ringer's lactate.

Lumbar puncture was performed in the lateral position at the L2–L3 or L3–L4 interspace under aseptic precautions using a 23-G spinal needle. After confirming free flow of clear cerebrospinal fluid, the allocated drug mixture was injected over 15–20 sec. The patient was then turned supine with a left lateral tilt and supplemental oxygen was administered via a face mask.

Outcome measures

Haemodynamic parameters (SBP, DBP, MAP, HR, SpO_2, RR) were recorded at baseline, every 5 min for the first 30 min, then every 15 min until the end of surgery. Hypotension was defined as a ≥20% fall in SBP from baseline and treated with IV mephenteramine 5 mg bolus. Bradycardia (HR<60 bpm) was managed with atropine 0.6 mg IV.

Sensory block was assessed by the pin-prick method at 2-minute intervals up to 10 min. Onset of sensory block was recorded as the time from intrathecal injection to loss of pin-prick sensation at T10. The time to achieve maximum sensory level (T6) was also noted [16, 13].

Motor block was evaluated using the Modified Bromage Scale at 2 min intervals up to 10 min. Scale scores ranged from 1 (complete block, unable to move feet or knee) to 6 (able to perform partial knee bend).

Sedation was assessed using the Modified Ramsay Sedation Scale (MRSS) every 5 min for 30 min then every 15 min [16]. Patients scoring ≥3 were considered sedated.

Duration of analgesia was defined as the time from intrathecal injection to a Visual Analogue Scale (VAS) score of ≥4. Rescue analgesia (diclofenac 75 mg IV) was administered when VAS ≥4.

Complications including nausea, vomiting, pruritus, urinary retention, headache, and respiratory depression were documented and managed as per standard protocols.

Statistical analysis

Continuous variables are expressed as mean±SD. Normality was tested by the Kolmogorov–Smirnov and Shapiro–Wilk tests. Between-group differences for continuous variables were compared using the Kruskal–Wallis H test, with post-hoc pairwise comparisons. Categorical variables were analysed by the Chi-square or Fisher exact test. A p value<0.05 was considered statistically significant. All analyses were performed using IBM SPSS Statistics version 21.

RESULTS

Demographic profile

All three groups were comparable with respect to age, weight, and ASA physical status (table 1). No statistically significant difference was observed in any demographic parameter (p>0.05).

Table 1: Demographic profile of patients (Mean±SD)

Parameter	Group I (n=50) levo plain	Group II (n=50) levo+12.5 µg fentanyl	Group III (n=50) levo+25 µg fentanyl	P Value
Age (years)	26.54±3.26	26.68±3.17	26.48±3.35	0.945 (NS)
Weight (kg)	61.94±6.63	62.18±6.60	63.42±6.40	0.481 (NS)
ASA I/II	38/12	37/13	33/17	0.499 (NS)

NS = not significant

Haemodynamic parameters

Heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), oxygen saturation (SpO2), and respiratory rate (RR) were stable throughout the intraoperative period in all three groups. No statistically significant inter-group differences were observed at any time point (p>0.05). No patient required treatment for hypotension or bradycardia related to the study drugs.

Sensory and motor block characteristics

A dose-dependent enhancement of block characteristics was observed with increasing fentanyl dose (table 2). Onset of sensory block was fastest in Group III (1.66 min) versus Group II (2.41 min) and Group I (3.90 min) (p<;0.05). Time to reach maximum sensory level (T6) was 2.72, 3.23, and 8.07 min in Groups III, II, and I respectively (p<0.05). Motor block onset (Modified Bromage score ≤2) was also significantly earlier in the fentanyl groups.

Table 2: Sensory block, motor block, and analgesia duration (mean±SD)

Parameter	Group I Group I (n=50) levo plain	Group II (n=50) levo+12.5 µg fentanyl	Group III (n=50) levo+25 µg fentanyl	P value
Onset of sensory block (min)	3.90	2.41	1.66	<0.001(S)
Time to reach max sensory level (min)	8.07	3.23	2.72	<0.001(S)
Motor block onset (Bromage 2, min)	~10	~4	~2.7	<0.001(S)
Duration of analgesia (min)	220±18.94	306±26.34	372.8±22.59	<0.001(S)
p value (inter-group)	—	<0.001 vs I	<0.001 vs I and II	

P<;0.05 for all inter-group comparisons (S=significant)

Sedation

All patients maintained a Modified Ramsay Sedation Score of 2 (cooperative, oriented, and tranquil) throughout surgery. No patient required additional sedation and no significant inter-group difference in sedation level was detected (pandgt; 0.05).

Duration of analgesia

Mean duration of postoperative analgesia was significantly prolonged with increasing fentanyl dose: 220.0±18.94 min in Group I, 306.0±26.34 min in Group II, and 372.8±22.59 min in Group III (pandlt; 0.001 for all pairwise comparisons). Group III thus provided approximately 2.5 h of additional analgesia compared with Group I and 1.1 h compared with Group II.

Complications

Nausea, vomiting, and pruritus occurred more frequently with increasing fentanyl dose, reaching statistical significance (pandlt; 0.05) (table 3). No cases of respiratory depression, headache, or urinary retention were recorded in any group. No post-operative complications were documented.

Table 3: Intraoperative complications

Complication	Group I n (%)	Group II n (%)	Group III n (%)	
Nausea	3 (6%)	6 (12%)	15 (30%)	S
Vomiting	1 (2%)	6 (12%)	11 (22%)	S
Pruritus	0 (0%)	2 (4%)	10 (20%)	S
Headache	0 (0%)	0 (0%)	0 (0%)	NS
Urinary Retention	0 (0%)	0 (0%)	0 (0%)	NS
Respiratory Depression	0 (0%)	0 (0%)	0 (0%)	NS

P<0.05 for nausea, vomiting and pruritus inter-group comparison (s=significant, ns=non significant)

DISCUSSION

This prospective, randomised, double-blind trial evaluated the effects of two doses of intrathecal fentanyl (12.5 µg and 25 µg) combined with 0.5% hyperbaric levobupivacaine in 150 patients undergoing elective LSCS. The principal findings were: (i) a dose-dependent acceleration of sensory and motor block onset; (ii) a dose-dependent prolongation of postoperative analgesia; (iii) comparable haemodynamic stability across all groups; and (iv) a higher incidence of nausea, vomiting, and pruritus with the 25 µg dose.

The accelerated sensory block onset observed with fentanyl addition is consistent with the literature. Attri *et al.* [13] reported significantly faster sensory block onset with levobupivacaine–fentanyl versus levobupivacaine alone. Similarly, Ozyilkan *et al.* [16] demonstrated that intrathecal sufentanil or fentanyl produced earlier sensory block onset compared with plain levobupivacaine. Patel AK *et al.* [17] found onset at 4.74±0.72 min in the fentanyl group versus 5.7±0.95 min in the plain levobupivacaine group. These observations align with the synergistic interaction between opioids and local anaesthetics at spinal opioid receptors, which reduces the minimum local anaesthetic concentration required for adequate blockade.

The marked prolongation of analgesia in Group III (372.8 min versus 220.0 min in Group I) is clinically significant. Bidikar *et al.* [15] reported that fentanyl added to intrathecal levobupivacaine extended sensory block duration without increasing motor block duration, facilitating earlier ambulation. Rajasekaran *et al.* [14] and Nahakpam *et al.* [18] similarly confirmed dose-dependent prolongation of analgesia with increasing fentanyl doses. Arikan M *et al.* [19] observed prolonged analgesia with 25 µg fentanyl compared with 10 µg when combined with levobupivacaine for caesarean section. The present findings corroborate this dose–response relationship.

Haemodynamic stability was maintained across all three groups, consistent with reports by Attri *et al.*, [13] Cuvas *et al.*, [11] and Rao GD *et al.* [20] The absence of clinically significant hypotension or bradycardia requiring treatment is reassuring and may be attributed to the moderate dose of local anaesthetic used (10 mg) and adequate prehydration. Gouroji *et al.* [21] similarly reported no significant haemodynamic differences when fentanyl was added to isobaric levobupivacaine.

The higher incidence of pruritus in Group III (20% versus 4% in Group II and 0% in Group I) is an expected adverse effect of intrathecal opioids, most likely mediated by cephalad migration in the CSF and interaction with opioid receptors in the trigeminal nucleus. This is consistent with results reported by Rajasekaran *et al.* [14] (15% pruritus with fentanyl) and Kopacz *et al.* [22] The increased nausea (30%) and vomiting (22%) in Group III also mirror findings by Rajasekaran *et al.* [14] All these adverse effects are self-limiting and manageable with standard antiemetic and antihistamine therapy.

The absence of respiratory depression, headache, or urinary retention in any group is consistent with the established safety profile of low-dose intrathecal fentanyl in obstetric patients.

A limitation of this study is that neonatal outcomes (Apgar scores, cord blood gases) were not assessed systematically; future studies should include these endpoints. Additionally, the study was conducted at a single centre, which may limit generalisability.

CONCLUSION

The addition of fentanyl to 0.5% hyperbaric levobupivacaine for spinal anaesthesia in elective LSCS produces a clinically significant, dose-dependent improvement in block quality and prolongation of postoperative analgesia. The 25 µg dose provides the fastest onset and longest analgesia but is associated with a higher rate of pruritus, nausea, and vomiting compared with 12.5 µg. Both doses maintained haemodynamic stability and no respiratory depression was observed. We recommend 0.5% hyperbaric levobupivacaine 10 mg with fentanyl 25 µg as the preferred intrathecal combination for elective LSCS; however, clinicians should weigh the superior analgesic profile against the increased risk of opioid-related side effects, particularly pruritus and nausea.

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AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

The authors declare no conflict of interest. No external funding was received for this study.

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