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Comparative study of hyperbaric bupivacaine 0.5% versus hyperbaric bupivacaine 0.5% and fentanyl in spinal anaesthesia for lower abdominal and lower extremity surgeries

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Abstract
The study was conducted to compare the differences in the onset, duration of action of intrathecal hyperbaric bupivacaine 0.5% (group-I) versus intrathecal hyperbaric bupivacaine 0.5% and fentanyl 25 µg (group-II) in spinal anaesthesia in lower abdominal and lower extremity surgeries. The combination of bupivacaine and fentanyl helps anaesthesiologist to alleviate intraoperative discomfort by providing better analgesia to the patients without prolonging recovery. 100 patients belonging to ASA grade-I and II of both the sexes (n=50 in each group) were randomly selected for the study. The time of onset of sensory and motor block, duration of analgesia, 2-segment regression, intraoperative discomfort, time to micturition, visual analogue score, post operative analgesic requirements were assessed. The time of onset of sensory and motor block were significantly longer in group-II than group-I (P<0.001). The 2-segment regression of sensory blockade (group-I – 78.60±6.23 and group-II – 114.58±4.15 min) and regression of sensory level to L_2 dermatome (group-I – 142.90±6.71 and group-II – 166.80±5.69 min) were significantly longer in group-II (P<0.001). Addition of intrathecal fentanyl 25 µg to hyperbaric bupivacaine in spinal anaesthesia provides better quality of anaesthesia with reduced incidence of perioperative discomfort, prolonged duration of analgesia and reduced postoperative analgesic requirements.

Keywords: Analgesia, bupivacaine, fentanyl, intrathecal, regression, subarachnoid block, visual analogue score

Introduction
Spinal anaesthesia consists of the temporary interruption of nerve transmission within the subarachnoid space produced by injection of a local anaesthetic solution into cerebrospinal fluid. Used widely, safely and successfully for almost 100 years, spinal anaesthesia has many potential advantages over general anaesthesia, especially for operations involving the lower abdomen, the perineum and the lower extremities [1].

Safe practice of spinal anaesthesia includes properly selecting and preparing the patient, accessing the cerebrospinal fluid, administering appropriate anaesthetic drugs and adjuvants, managing physiologic side effects and overseeing the patient throughout the procedure as well as in the early recovery period [2].

Spinal anaesthesia is advantageous, in that it uses a small dose of anaesthetic, is simple to perform and offers a rapid onset of action, gives reliable surgical analgesia and good muscle relaxation [3].

Spinal anaesthesia with hyperbaric bupivacaine 0.5% is a popular method, but there is a need for increasing the duration of analgesia without increasing the duration of motor blockade, thus prolonging post-operative analgesia, reducing post-operative analgesic requirements, facilitating early ambulation, thereby resulting in early discharge of the patient. The combination of bupivacaine and fentanyl helps the anaesthesiologist to alleviate intraoperative discomfort to the patient by providing better analgesia without prolonging the recovery [4].

Mechanism of action of Bupivacaine is similar to that of any other local anaesthetics. The primary action of local anaesthetics is on the cell membrane of the axon, on which it produces electrical stabilization. The large transient increase in permeability to sodium ions necessary for propagation of the impulse is prevented. Thus the resting membrane potential is maintained and depolarization in response to stimulation is inhibited.

Initially, the threshold for electrical excitation is raised, the rate of rise of action potential reduced and conduction slowed. Eventually propagation of the impulse fails [5].

Fentanyl is primarily a μ receptor agonist with an analgesic potency greater than morphine, pethidine and alfentanyl.

Analgesia is produced principally through interaction with μ receptors at supraspinal sites. It also binds to a much lesser degree to kappa receptors located within the spinal cord. There is evidence now that the gray matter of the spinal cord also contains opioid receptors and most of them are located in substantia gelatinosa. i.e 50% kappa, 40% μ and 10% Delta [6].

Methodology

Patients were allocated into two groups viz.,

Group-I: 50 patients receiving 3 ml of hyperbaric bupivacaine 0.5%

Group-II: 50 patients receiving 3 ml of hyperbaric bupivacaine 0.5% with 0.5 ml (25 μg) of fentanyl.

Before the start of the procedure, patients' pulse rate, blood pressure, respiratory rate, SpO_2 were recorded. A life-line was secured using a 18G intravenous cannula. All patients were preloaded with 500 ml of Ringer's lactate prior to spinal anaesthesia. The patients were kept nil per orally for 8-10 hours before surgery.

All the patients were instructed about the Visual Analogue Scale (VAS). A visual analogue scale made by using ten beads on a string and graded as no pain (1-bead) and worst pain (10 beads). The intensity of pain gradually increases from 1st to 10th bead. The patients were informed to point out the intensity of pain on the scale.

Under strict aseptic precautions, lumbar puncture was performed in left lateral position or sitting position by midline approach by using disposable quinke spinal needle (22-25G) at L_3-L_4 intervertebral space.

Patients were monitored continuously using sphygmomanometer, pulse oximeter and electrocardiogram.

After spinal anaesthesia, the patients' pulse rate and blood pressure were recorded at 0, 5, 10, 20, 30, 60, 120 and 180 minutes.

Assessment of Sensory Blockade

This was tested by pin-prick method. The time of onset was taken from time of injection of the drug into the subarachnoid space to loss of pin-prick sensation. The time to achieve maximum sensory block was noted from time of injection of drug to loss of pin-prick sensation at highest dermatomal level. The time for two dermatomal segments regression of sensory level was noted. Duration of sensory blockade was recorded from time of onset to time of return of pin-prick sensation to L_2 dermatomal area. During post-operative period, analgesics or opioids were avoided until demanded by the patient due to pain. The patients were asked to point out the intensity of pain on the linear visual analogue scale.

The total number of times analgesics/ opioids given to the patients in the 24 hours period was noted in either groups.

Assessment of Motor Blockade

This was assessed by Bromage scale. The time interval between injection of drug into subarachnoid space, to the patients' inability to lift the straight extended leg was taken as onset time. The time to achieve maximum motor blockade was noted from time of injection of the drug to maximum degree of motor block.

Duration of motor block was recorded from onset time to time when the patient was able to lift the extended leg.

Bromage Scale

0 - Full flexion of knees and feet
1 - Just able to flex knees, full flexion of feet.
2 - Unable to flex knees, but some flexion of feet possible.
3 - Unable to move legs or feet.

Results

Table 1: Onset of sensory blockade (seconds) in either groups

Group –I	Group-II	Z–Value	Significance
Mean ± S.D.	Mean ± S.D.		
152.80±11.03	181.30±10.56	13.19	P<0.001

The difference between the groups was statistically highly significant (P<0.001).

Table 2: Onset of motor blockade (seconds)

Group –I	Group-II	Z–Value	Significance
Mean ± S.D.	Mean ± S.D.		
219.80±10.95	264.30±9.56	21.65	P<0.001

The difference between the groups was statistically highly significant (P<0.001).

Table 3: Two dermatomal segments regression of sensory level (minutes)

Group –I	Group-II	Z–Value	Significance
Mean ± S.D.	Mean ± S.D.		
78.60±6.23	114.58±4.15	33.98	P<0.001

The difference between either groups was highly significant (P<0.001).

Table 4: Regression of sensory level to L_2 dermatome (minutes)

Group –I	Group-II	Z–Value	Significance
Mean ± S.D.	Mean ± S.D.		
142.90±6.71	166.80±5.69	19.21	P<0.001

The difference between either groups was highly significant (P<0.001).

Table 5: Time (in minutes) for complete motor recovery

Group –I	Group-II	Z–Value	Significance
Mean ± S.D.	Mean ± S.D.		
183.60±8.33	207.70±5.46	2.34	P< 0.05

The difference between the groups was statistically significant (P<0.05).

Table 6: Time (in minutes) for first request of analgesics by the patients in either groups

Group –I	Group-II	Z–Value	Significance
Mean ± S.D.	Mean ± S.D.		
210.20±6.77	363.90±10.99	86.06	P<0.001

The difference between the groups was statistically highly significant (P<0.001).

Table 7: Visual analogue scores at different time intervals

Time	Group –II	Group-I	Z–Value	Significance
	Mean ± S.D.	Mean ± S.D.		
3 Hrs	0.68±1.70	0.04±0.20	2.64	P<0.05
6 Hrs	3.80±0.96	1.12±0.53	17.28	P<0.001
12 Hrs	4.52±1.16	1.52±0.65	15.95	P<0.001

The difference between the groups was statistically significant at all the three time intervals recorded (At 3 Hours $P<0.05$, At 6 Hours $P<0.001$, At 12 Hours $P<0.001$).

Discussion

In the present study the onset of sensory and motor blockade was delayed significantly in group II. This shows that addition of fentanyl to local anaesthetic delays the onset of anaesthesia. Harbhej Singh *et al.* [7] in 1995 found that fentanyl did not enhance the onset of bupivacaine induced sensory or motor block. Lee BB *et al.* [8] in 1999 found no change in the onset of sensory or motor block when intrathecal fentanyl 25µg was used with 1.25 mg and 2.5 mg bupivacaine respectively.

From the above studies we can conclude that, though there is variation in the onset of sensory and motor blockade in different studies, it is only statistically significant but does not have any clinical implications. We found in this study that two segment regression of sensory level was significantly prolonged in fentanyl group (group II).

Harbhej Singh *et al.* [7] in 1995, Harbhej Singh [9] in 1998, Lee BB *et al.* [8] in 1999, Goel S *et al.* [10] in 2003, Techanivate A *et al.* [11] in 2004 found that two segment regression of sensory level was significantly prolonged in patients who received fentanyl along with bupivacaine intrathecally. Thus we can conclude that intrathecal fentanyl increases the intensity of sensory blockade.

In the current study, the duration of motor blockade was significantly prolonged in group II. This signifies that fentanyl potentiates the motor blockade provided by bupivacaine.

Lee BB *et al.* [12] in 1999, Goel S *et al.* [10] in 2003, Techanivate A *et al.* [11] in 2004, Jain K *et al.* [13] in 2004 concluded that fentanyl increases the duration and intensity of bupivacaine spinal anaethesia, where as Harbhej Singh [9] in 1998, Jih-Ching Cheng C *et al.* [14] in 2001, Teoh WHL *et al.* [15] in 2003 concluded that fentanyl does not prolong the duration of motor blockade but it only increases the time of sensory blockade without prolonging recovery to micturition or street fitness.

Thus we can conclude that intrathecal bupivacaine with fentanyl increases only sensory blockade in lower concentration but increases the duration of motor blockade in higher concentrations.

In the current study, the time of first request of analgesics in group I was 210 min in contrast with 363 min in the later group. There was significantly longer period of analgesia with intrathecal fentanyl.

Harbhej Singh [9] in 1998 concluded that intrathecal fentanyl 25µg with 0.5% bupivacaine reduced analgesic requirements in the early post operative period.

Jih-Ching Cheng C *et al.* [14] in 2001 found that 25µg fentanyl was good alternative to sufentanil 5µg when added to bupivacaine 1.25mg for early labour analgesia.

Cowan CM *et al.* [16] in 2002 studied co-administration of small doses of opioids and bupivacaine for spinal anaesthesia. They concluded that opioids reduce intraoperative discomfort and reduce immediate post-operative analgesic requirements in patients undergoing caesarean section.

Siddik Sayyid *et al.* [17] in 2002 studied intrathecal and IV fentanyl along with intrathecal bupivacaine for caesarean section. They found that additional supplementation was required in IV group where as in intrathecal group no supplementation was required and the time for first request of analgesics was longer in intrathecal fentanyl group.

Thus we can conclude that intrathecal fentanyl along with bupivacaine prolongs the duration of analgesia thus prolonging the first request of supplemental analgesics in the post operative period. It also improves the quality of anaesthesia.

In this study, there as significant reduction in the visual analogue pain scores (VAS) of the patients in group II in comparison with higher VAS scores in group I recorded at 3 hours, 6 hours and 12 hours of spinal anaesthesia.

Hunt CO *et al.* [18] in 1987, Cascio M *et al.* [19] in 1997, Lee BB *et al.* [8] in 1999, Khanna MS *et al.* [20] in 2002, Teoh WHL *et al.* [15] in 2003, Techanivate A *et al.* [11] in 2004 found that use of intrathecal fentanyl significantly reduces the pain scores in the early post operative period extending upto 12 hours. Whereas Cowan CM *et al.* [16] in 2002 found reduced VAS scores only 1 hour after caesarean section after which pain scores were similar in both the groups.

From the above studies we can conclude that intrathecal fentanyl potentiates the sensory blockade of bupivacaine, thereby reduce the visual analogue scores in the early post operative period upto 12 hours of the administration of spinal anaesthesia, bringing about better post operative outcome.

Conclusion

Intrathecal fentanyl 25µg in addition to bupivacaine in spinal anaethesia provides a cost-effective post-operative management by prolonging the duration of analgesia and reduced postoperative analgesic requirements.

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