Section: Anaesthesiology

Original Research Article

A COMPARATIVE STUDY OF INTRATHECAL NALBUPHINE VERSUS FENTANYL AS ADJUVANT TO 0.5% HYPERBARIC BUPIVACAINE FOR ORTHOPEDIC SURGERY OF LOWER LIMBS UNDER SUBARACHNOID BLOCK

D. Sasikumar[1], M Selvam[2], H.M.Haja Shareef[3], S.Saravanakumar[3]

[1]Assistant Professor, Department of Anaesthesiology, Govt Kilpauk Medical College and Hospital, Chennai, Tamil Nadu, India
[2]Assistant Professor, Department of Anaesthesia, Government Medical College and Hospital Tiruvallur, Tamil Nadu, India
[3]Associate Professor
Department of Anaesthesia, Government Medical College and Hospital, Kallakurichi, India.

Received : 20/12/2023
Received in revised form : 31/01/2024
Accepted : 15/02/2024

Keywords:
Nalbuphine, bupivacaine, fentanyl, sensory block, postoperative analgesia.

Corresponding Author:
Dr. M. Selvam,
Email: selvam0803@gmail.com

DOI: 10.47009/jamp.2025.7.1.99

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (1); 514-519

Abstract

Background: Spinal anaesthesia has advantages over general anaesthesia, including reduced stress response and enhanced postoperative analgesia. Neuraxial opioids, such as fentanyl and nalbuphine, improve intraoperative anaesthesia and prolong postoperative pain relief. This study compared the efficacy of intrathecal nalbuphine versus fentanyl as adjuvants to 0.5% hyperbaric bupivacaine in spinal anaesthesia. **Materials and Methods:** This prospective, non-randomised, single-blind study included 60 patients who underwent lower limb surgery under spinal anaesthesia. Patients were divided into two groups: Group F (n=30) received 3.5 ml of 0.5% hyperbaric bupivacaine with 25 mcg fentanyl, and Group N (n=30) received 3.5 ml of 0.5% hyperbaric bupivacaine with 2 mg nalbuphine. Sensory and motor block characteristics, haemodynamic parameters, and analgesia duration were assessed intraoperatively and postoperatively, with monitoring for up to 12 h post-surgery. **Result:** The two groups did not differ significantly in terms of age, weight, sex, or haemodynamic parameters. The onset of sensory block at T10 was slightly longer in Group F (4.67±0.36 min) than in Group N (3.49±0.51 min, p=0.2296). The sensory blockade and motor block onset times were similar. However, two-segment regression was significantly longer in Group N (121.57±9.04 min) than in Group F (113.57±7.86 min, p=0.0005). Motor block duration (187.63±12.27 min vs. 139.90±10.97 min, p<0.0001) and time to first rescue analgesia (308.13±12.66 min vs. 278.20±18.97 min, p<0.0001) were also significantly prolonged in Group N. However, Ramsay sedation and VAS scores varied significantly at specific time points. **Conclusion:** Nalbuphine (2 mg) with 0.5% hyperbaric bupivacaine was more effective than fentanyl in prolonging sensory-motor block and enhancing postoperative analgesia for lower limb surgeries, with minimal adverse effects, making it a superior intrathecal adjuvant.

INTRODUCTION

The regional anaesthetic technique of spinal anaesthesia offers many advantages over general anaesthesia, such as reduced stress response to surgery and increased postoperative analgesia. Neuraxial administration of opioids in conjunction with local anaesthetics improves the quality of intraoperative analgesia and prolongs the duration of postoperative analgesia without increasing the sympathetic block. The commonly added opioids to local anaesthetics potentiate the effects of local anaesthetics, reduce their dose, complications, and side effects, and offer haemodynamic stability.

Among various adjuvants, intrathecal opioids have been shown to effectively prolong postoperative analgesia after orthopaedic surgeries.[1,2] Opioid analgesics activate opioid receptors located on primary afferent neurones, resulting in pain modulation. Their activation may directly decrease neurotransmission or inhibit the release of excitatory neurotransmitters. Analgesia with neuraxial opioids is dose-related and specific for visceral rather than somatic pain.[3] Both Fentanyl and nalbuphine are

opioid analgesics Fentanyl is an opioid agonist and acts on mu-opioids receptors.[4]

Nalbuphine is a synthetic opioid analgesic with agonist-antagonist activity; it acts as an antagonist at mu receptors and an agonist at kappa receptors. To provide reasonably potent analgesia. Nalbuphine, when used as an adjuvant to hyperbaric bupivacaine, has improved the quality of perioperative analgesia with fewer side effects.[5] There is no documentary evidence of neurotoxicity following intrathecal nalbuphine use.[6,7]

Aim

This study aimed to compare the efficacy of intrathecally administered nalbuphine versus intrathecally administered fentanyl as an adjuvant to 0.5% hyperbaric bupivacaine.

MATERIALS AND METHODS

This prospective, randomised, double-arm, single-blind, controlled study includes 60 patients undergoing lower limb surgeries under subarachnoid block at the Department of Anaesthesiology, Govt Kilpauk Medical College and Hospital and Govt Royapettah Hospital, Chennai, between February 2017 and July 2017. The Institutional Ethics Committee approved the study before initiation, and informed consent was obtained from all patients.

Inclusion Criteria

Patients aged 30–60 years, including both males and females, who were undergoing elective lower limb surgeries under subarachnoid block and were classified as ASA class 1 or 2 were included.

Exclusion Criteria

Patients with known allergy or sensitivity to opioid drugs or local anaesthetics, spinal deformities, any contraindication to spinal anaesthesia, neurological disorders, impaired ability to communicate due to confusion, poor hearing, or language barriers, those who were unconscious or severely ill, pregnant women, and those with coagulation disorders were excluded.

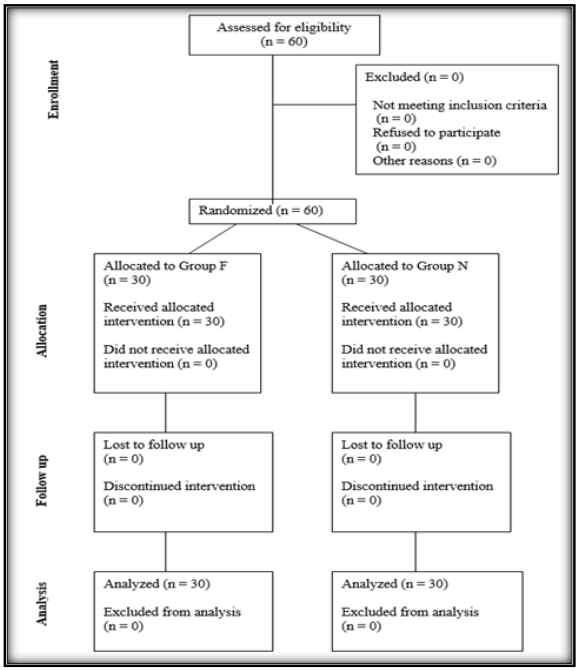

Figure 1: CONSORT flowchart

Methods: Sixty patients were included and divided into two groups using computerised randomisation. Group F (n=30) received 3.5 ml of 0.5% Hyperbaric Bupivacaine with 25 mcg Fentanyl, and Group N (n=30) received 3.5 ml of 0.5% Hyperbaric Bupivacaine with 2 mg nalbuphine, making a total intrathecal drug volume of 4 ml for each patient. This study involved preoperative evaluation, clinical examination, and necessary investigations before assessment. Patients fasted overnight, and before anaesthesia, they were informed about sensory and motor blockade assessments and the visual analogue scale (VAS) for pain measurement (ranging from 0 = no pain to 10 = worst possible pain).

In the operating theatre, standard monitoring, including heart rate (HR), non-invasive blood pressure (BP), electrocardiogram, and pulse oximetry (SpO2), was conducted at 5-minute intervals. Under aseptic precautions, spinal anaesthesia was administered via the midline approach in a sitting position at the L3–L4 intervertebral space using a 25-gauge Quincke spinal needle. The study drug solution was administered intrathecally according to group allocation, and the patient was placed in the supine position.

Sensory and motor block characteristics were evaluated every 2 min until the loss of pinprick sensation in the normal lower limb was achieved. The time intervals were recorded from the end of the intrathecal injection. The sensory block onset (time to reach T10), maximum cephalic level, time to maximum sensory block, and two-segment regression time were noted. Motor block grading followed the Modified Bromage Scale: 0 = no motor block; 1 = inability to raise the extended leg but able to move the knees and feet; 2 = inability to raise the extended leg and move the knee but able to move

ISSN (O): 2687-5365; ISSN (P): 2753-6556

the feet; and 3 = complete motor block. Surgical anaesthesia was deemed adequate when the sensory block reached T10 or above with a complete motor block (Bromage 3).

For block recovery, the time for two-segment regression and complete motor recovery was noted. The duration of effective analgesia was defined as the time from spinal injection to the first rescue analgesic administration when the VAS score was ≥3. Patients with VAS ≥3 received 100 mg intramuscular Inj Tramadol, marking the study's endpoint. Sensory and motor block levels were assessed every 15 min postoperatively until full recovery. Hypotension was managed by increasing the infusion rate of crystalloids or administering 6 mg IV Inj Ephedrine if needed. Bradycardia was treated with IV Inj Atropine (0.6 mg).

The study assessment criteria included the onset time of sensory block at T10, time to achieve maximum sensory blockade, time for complete motor block, two-segment sensory regression time, motor block duration, time to first rescue analgesia, Ramsay score, postoperative nausea and vomiting, heart rate, blood pressure, respiratory rate, oxygen saturation, and pruritus. Sixty patients undergoing elective lower limb surgeries under spinal anaesthesia were individually assessed intraoperatively and postoperatively. Sensory and motor blockade characteristics were recorded every 2 min, and other parameters were monitored every 15 min for the first two hours, followed by hourly monitoring for up to 12 h in the postoperative care unit. The duration of analgesia was measured from intrathecal blockade to the first rescue analgesic (Inj Tramadol 100 mg), and the number of vomiting episodes was recorded.

Statistical analysis: Data are presented as mean, standard deviation, frequency, and percentage. Continuous variables were compared using the independent sample t-test. Categorical variables were compared using Pearson's chi-square test. Significance was defined as P values less than 0.05 using a two-tailed test. Data analysis was performed using IBM-SPSS version 21.0.

RESULTS

The mean age in Group F was 48.40±11.36 years, whereas that in Group N was 46.10±13.51 years, showing no significant differences (p=0.4782). The mean weight in Group F was 65.40±7.50 kg, whereas in Group N, it was 68.67±12.55 kg, showing no significant differences (p=0.2259) [Table 1].

Table 1: Comparison of patient demographics between groups.

	Mean ± S.D.		P value
	Group F	Group N	
Age (in years)	48.40±11.36	46.10±13.51	0.4782
Weight (kg)	65.40±7.50	68.67±12.55	0.2259

Regarding age distribution, none of the patients in Group F were aged ≤ 20 years, whereas 10% of the patients in Group N were aged ≤ 20 years. Most patients (63.3%) in both groups were aged between 41-60 years, while 10% in each group were older than 60 years, with no significant difference (p=0.101). Regarding sex, males were predominant in both groups (63.3% in Group F and 66.7% in Group N), with no significant difference (p=0.7869). Regarding weight distribution, the highest proportion of patients in both groups weighed between 61-70 kgs (46.7% in Group F, 43.3% in Group N). A small proportion of patients in Group N (6.7%) weighed above 80 kg, whereas none in Group F weighed above 80 kg, with no significant difference (p=0.506). Nausea/vomiting was reported by only two patients (6.67%) in Group F, while none were reported in Group N, with no significant differences (p=0.149). Pruritus was reported by only one patient (3.3%) in Group F, while none of the patients in Group N reported pruritus, with no significant difference (p = 0.3131) [Table 2].

Table 2: Demographic and clinical characteristics of study groups

		N (%)		P value
		Group F	Group N	
Age (in years)	≤ 20	0	3(10.0%)	0.101
	21-40	8(26.7%)	5(16.7%)	
	41-60	19(63.3%)	19(63.3%)	
	> 60	3(10.0%)	3(10.0%)	
Sex	Male	19(63.3%)	20(66.7%)	0.7869
	Female	11(36.7%)	10(33.3%)	
Weight (kg)	≤ 60	10(33.3%)	8(26.7%)	0.506
	61-70	14(46.7%)	13(43.3%)	
	71-80	6(20.0%)	7(23.3%)	
	>80	0	2(6.7%)	
Nausea/Vomiting Status	Yes	2(6.67%)	0	0.149
	No	28(93.33%)	30(100%)	
Pruritus status	Yes	1(3.3%)	0	0.3131
	No	29(96.7%)	30(100.0%)	

ISSN (O): 2687-5365; ISSN (P): 2753-6556

The mean onset time of the sensory block at the T10 level was longer in Group F (4.67±0.36 min) than in Group N (3.49±0.51 min), but the difference was not significant (p=0.2296). The mean time to achieve sensory blockade at the most cephalic level was 7.20±1.79 min in Group F and 6.42±0.96 min in Group N, with no significant differences (p=0.4891). The mean time required to achieve complete motor block was longer in Group F (8.43±1.15 min) than in Group N (7.76±1.26 min), but the difference was not significant (p=0.5482).

The mean time taken for the two regressions of the sensory block was longer in Group N (121.57±9.04 min) than in Group F (113.57±7.86 min), with a significant difference (p=0.0005). The mean duration of the motor block was significantly prolonged in Group N (187.63±12.27 min) than in Group F (139.90±10.97 min) (p<0.0001). The mean time to administer the first rescue analgesia was longer in Group N (308.13 ± 12.66 min) than in Group F (278.20±18.97 min), with significant differences (p<0.0001) [Table 3].

Table 3: Sensory and motor blockade profile

	Mean ± S.D.		P value
	Group F	Group N	
Onset time of sensory block at T10 level (mins)	4.67±0.36	3.49±0.51	0.2296
Time taken to achieve sensory blockade at most cephalic level (mins)	7.20±1.79	6.42±0.96	0.4891
Time taken to achieve complete motor block (mins)	8.43±1.15	7.76±1.26	0.5482
Time taken for two regressions of sensory block (min)	113.57±7.86	121.57±9.04	0.0005
Duration of Motor Block (mins)	139.90±10.97	187.63±12.27	<0.0001
Time to administer first rescue analgesia (mins)	278.20±18.97	308.13±12.66	<0.0001

The overall mean peripheral capillary oxygen saturation in group F was 99.80%, and in group N, the majority were in the same SPO2 level, showing no significant differences (p>0.05) [Figure 2].

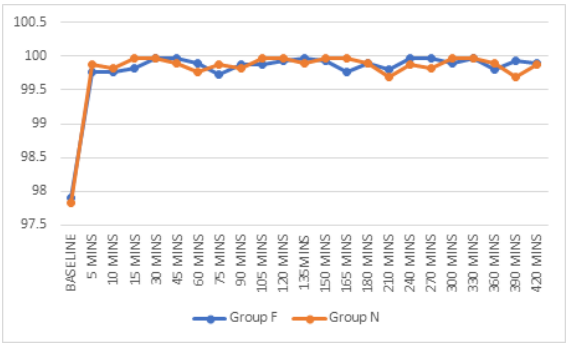

Figure 2: Mean peripheral capillary oxygen saturation

The overall mean respiratory rate in group F was 13.58 breaths/min, and in group N was 13.58 breaths/min, showing no significant differences (p>0.05) [Figure 3].

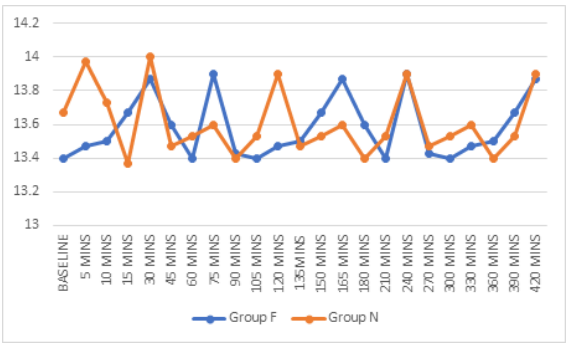

Figure 3: Mean respiratory rate

The overall mean heart rate in group F was 78.56 beats/min, and in group N was 84.44 beats/min, showing no significant differences (p>0.05) [Figure 4].

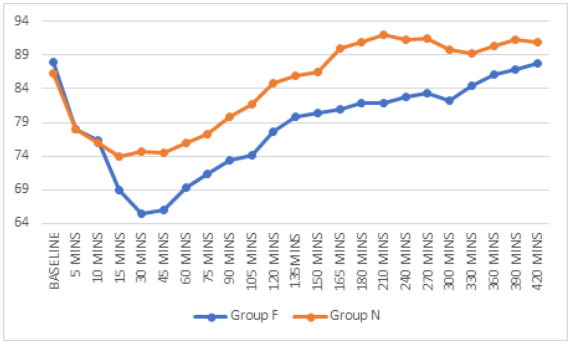

Figure 4: Mean heart rate

The overall mean arterial pressure in group F was 87.18 mmHg, and in group N was 87.21 mmHg, showing no significant differences (p>0.05) [Figure 5].

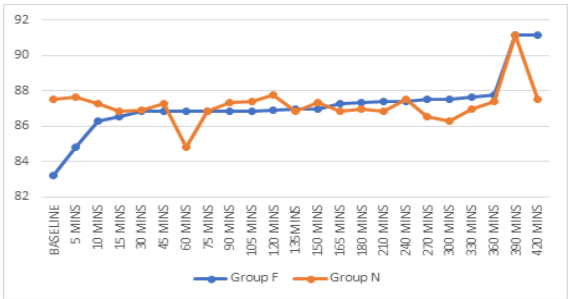

Figure 5: Mean arterial pressure

The overall mean Ramsay sedation score in group F was 1.22, and in group N was 1.04, showing significant differences at 90 min (p=0.0261), 105 min (p<0.0001), 120 min (p<0.0001), and 135 min (p=0.0192) [Figure 6].

ISSN (O): 2687-5365; ISSN (P): 2753-6556

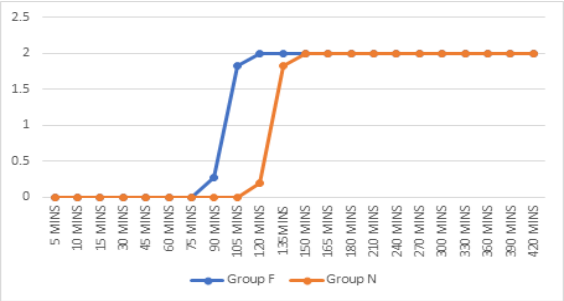

Figure 6: Mean Ramsay sedation score

The overall mean VAS score in Group F was 0.86, and in Group N was 0.84, showing significant differences at 135 min (p=0.0043), 150 min (p<0.0001), 165 min (p=0.0225), 180 min (p=0.0192), 210 min (p<0.0001), 240 min (p=0.0204), 270 min (p=0.0461), 300 min (p<0.0001), and 330 min (p=0.0002) [Figure 7].

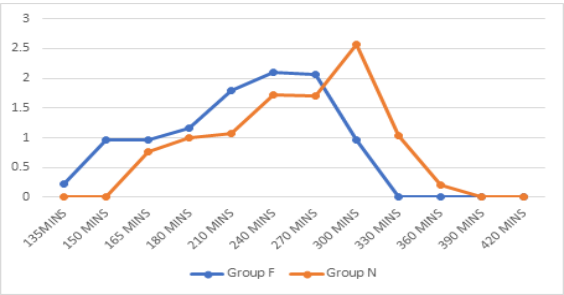

Figure 7: Mean VAS score

DISCUSSION

In our study, the onset time of the sensory block at the T10 level distribution between groups F and N was insignificant. This aligns with the study by Chandak et al., who found there is no significant difference in the onset time of sensory blockade between the two groups (p>0.05).8 In a study by Patwal et al., no significant difference was observed in the onset of sensory and motor block between the two groups (p>0.05).9 A study by Tiwari et al. reported onsets of sensory and motor blockades were not affected.[10]

In our study, the time taken to achieve sensory blockade at a most cephalic level between group F and group N shows no significant differences, as were the findings of the study conducted by Singh et al. reported that there was no significant difference seen in time to reach the highest level of sensory blockade in all the groups.[11] Study by Thote et al. reported There was no significant difference seen in time to reach the highest level of sensory blockade in both the groups and shows prolongation of sensory block in the fentanyl and nalbuphine groups.[12]

In our study, the time taken to achieve complete motor block between groups F and N showed no significant differences. A study conducted by Thote et al. reported the addition of fentanyl (25 µg) or nalbuphine (500 µg) to intrathecal bupivacaine does not prolong the motor block, showing no significant differences.[12]

In our study, the time taken for the two regressions of the sensory block between groups F and N showed significant differences. The mean time taken for the two regressions of the sensory block was 8.00 mean units less and 7% lower in group F than in group N (p<0.05). This finding is consistent with the results of a clinical comparative study by Singh et al. In their study, the time for sensory regression to S2 from HSL was calculated in all three groups. It reveals that all three groups are significantly different from each other (p<0.05) and more prolongation of sensory block duration in the nalbuphine group than in the fentanyl group and control group.[11]

A study by Chandak et al. reported that the two-segment regression time of sensory blockade was prolonged in the Nalbuphine group.[8] In a study by Patwal et al., the two-segment regression time was significantly prolonged in Group BN (98.16±9.86 mins) compared to Group B (77.33±9.35 mins).[9] A study by Tiwari et al. reported that a segment regression time of sensory blockade was maximally prolonged in group C (p<0.05).[10]

In our study, the duration of motor block between groups F and N showed significant differences. The mean duration of the motor block was 47.73 mean units and 25% lower in group F than in group N. A study by Tiwari et al. reported that the duration of motor blockade was not affected.[10]

In our study, the time to administer the first rescue analgesia differed significantly between groups F and N. The mean time to administer the first rescue analgesia was 29.93, with mean units less than 10% lower in group F than in group N. A study by Patwal et al. reported that the total duration of effective analgesia (time from intrathecal drug injection to the point of time when VAS ≥4) was also significantly prolonged in Group BN (302.4±27.59 mins) compared to Group B (180.83±25.90 mins).[9]

A study by Tiwari et al. reported that the duration of analgesia was maximally prolonged in group C (p<0.05).[10] Study by Singh et al. reported that the duration of analgesia was longer in both group I (Nalbuphine (404.5±22.82 mins) and group II (Fentanyl (295.5±21.82 mins) in comparison to control group III (265±23.5 mins). However, group I had a longer duration of analgesia than group II (404.5±22.82 mins Vs 295.5±21.82 mins).[11]

CONCLUSION

Our study concluded that intrathecal nalbuphine (2 mg) as an adjuvant to 0.5% hyperbaric bupivacaine (17.5 mg) for the subarachnoid block was clinically more efficient than fentanyl with 0.5% hyperbaric bupivacaine in extending the duration of sensory-motor block and enhancing postoperative analgesia following lower limb orthopaedic surgeries, with negligible adverse effects.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

REFERENCES

1. Roussel JR, Heindel L. Effects of intrathecal fentanyl on duration of bupivacaine spinal blockade for outpatient knee arthroscopy. AANA J 1999; 67:337–43. https://pubmed.ncbi.nlm.nih.gov/10497456/
2. Förster JG, Rosenberg PH. Clinically useful adjuvants in regional anaesthesia. Curr Opin Anaesthesiol 2003; 16:477–86. https://doi.org/10.1097/00001503-200310000-00007.
3. Hindle A. Intrathecal opioids in the management of acute postoperative pain. Contin Educ Anaesth Crit Care Pain 2008; 8:81–5. https://doi.org/10.1093/bjaceaccp/mkn016.
4. Tejwani GA, Rattan AK, McDonald JS. Role of spinal opioid receptors in the antinociceptive interactions between intrathecal morphine and bupivacaine. Anesth Analg 1992; 74:726–34. https://doi.org/10.1213/00000539-199205000-00018.
5. Gunion MW, Marchionne AM, Anderson CTM. Use of the mixed agonist–antagonist nalbuphine in opioid based analgesia. Acute Pain 2004; 6:29–39. https://doi.org/10.1016/j.acpain.2004.02.002.
6. Culebras X, Gaggero G, Zatloukal J, Kern C, Marti RA. Advantages of intrathecal nalbuphine, compared with intrathecal morphine, after cesarean delivery: an evaluation of postoperative analgesia and adverse effects. Anesth Analg 2000; 91:601–5. https://doi.org/10.1097/00000539-200009000-00019.
7. Mukherjee A, Pal A, Agrawal J, Mehrotra A, Dawar N. Intrathecal nalbuphine as an adjuvant to subarachnoid block: What is the most effective dose? Anesth Essays Res 2011; 5:171–5. https://doi.org/10.4103/0259-1162.94759.
8. Chandak VC, Sharma N. A comparison between intrathecal bupivacaine alone and intrathecal bupivacaine in combination with nalbuphine for post-operative analgesia. Int J Sci Res (Raipur) 2017; 6:1795–6. https://doi.org/10.21275/art20164337.
9. Patwa AA, Endigeri A, Upadhay MR. A comparison of intrathecal nalbuphine hydrochloride with hyperbaric bupivacaine 0.5% and hyperbaric bupivacaine 0.5% alone in patients undergoing abdominal hysterectomy. Int J Res Med 2014; 3:7–11. https://journals.indexcopernicus.com/search/article?articleId=1886839
10. Tiwari AK, Tomar GS, Agrawal J. Intrathecal bupivacaine in comparison with a combination of nalbuphine and bupivacaine for subarachnoid block: a randomized prospective double-blind clinical study: A randomized prospective double-blind clinical study. Am J Ther 2013; 20:592–5. https://doi.org/10.1097/MJT.0b013e31822048db.
11. Singh N, Kumar D, Rakesh Kumar Tyagi D. A Clinical comparative study of intrathecal nalbuphine versus intrathecal fentanyl added to 0.5% hyperbaric bupivacaine for postoperative anaesthesia and Analgesia in Lower Abdominal Surgeries: IOSRJDMS2017 n.d.;16:2279–0861. https://www.iosrjournals.org/iosr-jdms/papers/Vol16-issue3/Version-1/I1603013340.pdf
12. Thote RJ, Lomate P, Gaikwad S, Paranjpe JS, Mane M. Comparison among intrathecal fentanyl and nalbuphine in combination with bupivacaine and plain bupivacaine for lower limb surgeries. Int J Recent Trends Sci Technol 2015; 14:361–6. https://statperson.com/Journal/ScienceAndTechnology/Article/Volume14Issue2/14_2_28.pdf.

ISSN (O): 2687-5365; ISSN (P): 2753-6556