Section: Anaesthesiology

Original Research Article

A STUDY ON COMPARISON OF ONSET OF EPIDURAL ANAESTHESIA WITH BUPIVACAINE AND BUPIVACAINE WITH FENTANYL BY USING PERFUSION INDEX

Radhakrishnan Arulmozhi[1], Sendhil Kumar Mohan[2], Priyadharshini[3]

[1]Assistant Professor, Department of Emergency Medicine, Kapv Government Medical College, Trichy, Tamilnadu, India.
[2]Associate Professor, Department of Anaesthesiology, Kapv Government Medical College, Trichy, Tamilnadu, India.
[3]Assistant Professor, Department of Anaesthesiology, Kapv Government Medical College, Trichy, Tamilnadu, India.

Received : 19/04/2025
Received in revised form : 12/06/2025
Accepted : 01/07/2025

Keywords:
Epidural anaesthesia, Bupivacaine, Fentanyl, Perfusion index, Hernia surgery.

Corresponding Author:
Dr. Radhakrishnan Arulmozhi,
Email: rktroytmc08@gmail.com

DOI: 10.47009/jamp.2025.7.4.9

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

Int J Acad Med Pharm
2025; 7 (4); 44-49

ABSTRACT

Background: Epidural anaesthesia is widely employed in lower abdominal surgeries because of its effectiveness and haemodynamic stability. The addition of opioids, such as fentanyl, to local anaesthetics, such as bupivacaine, may influence the onset, duration, and block quality. The perfusion index (PI), a noninvasive pulse oximetry–based marker, objectively evaluates sympathetic blockade. **Objective:** To compare the onset and effectiveness of epidural anaesthesia using bupivacaine alone versus bupivacaine with fentanyl in elective hernia surgeries, using PI, mean arterial pressure (MAP), and heart rate as assessment parameters. **Material and Methods:** A prospective, randomised, double-blind study was conducted on 60 patients undergoing elective hernia surgery at K.A.P. Viswanatham Government Medical College in the Department of General Surgery at Group B received 12 ml of 0.5% bupivacaine with 0.5 ml saline, whereas Group BF received 12 ml of 0.5% bupivacaine with 25 µg fentanyl. PI, MAP, PR, onset of sensory block, duration of analgesia, and side effects were monitored. **Result:** Group BF showed a significantly faster sensory block onset (5.23 ± 1.14 min vs. 6.67 ± 1.21 min; $p < 0.001$) and prolonged analgesia (123.5 ± 13.24 min vs. 98.4 ± 10.21 min; $p < 0.0001$). The PI was significantly higher in Group BF from 8 to 14 min, indicating an earlier sympathetic blockade. Group BF had greater haemodynamic stability in terms of SBP and MAP ($p < 0.05$). Pruritus occurred in 30% of Group BF; nausea (10%) was equal in both groups; hypotension (10%) occurred only in Group B.; and no vomiting or urinary retention was noted. **Conclusion:** Fentanyl enhances the onset and duration of epidural anaesthesia with bupivacaine and improves haemodynamic stability. The PI serves as a sensitive, noninvasive indicator of block onset.

INTRODUCTION

Pain is defined as an unpleasant sensory and emotional experience linked to actual or potential tissue damage.1 Its effective management is essential in surgical practice to prevent physiological disturbances, including adverse effects on the cardiovascular, respiratory, endocrine, and metabolic systems.[2] This underscores the need for safe, efficient, and reliable anaesthetic techniques that ensure optimal perioperative outcomes.

John J. Bonica, a pioneer in the field of pain medicine, promoted multidisciplinary approaches to pain control.[3] Among various anaesthetic options, regional anaesthesia has emerged as a preferred technique in many surgical contexts, particularly for lower abdominal and limb surgeries.[4] Compared to general anaesthesia (GA), regional techniques such as epidural anaesthesia (EA) offer several advantages, including avoidance of airway manipulation, reduced systemic drug use, better haemodynamic stability, prolonged postoperative analgesia, and lower incidence of postoperative nausea and vomiting.[5]

EA is a central neuraxial block that provides segmental anaesthesia and allows flexibility in dosing and duration. Its utility spans surgical anaesthesia, postoperative analgesia, and chronic pain management.[6] Unlike spinal anaesthesia, EA avoids dural puncture, reducing the risk of PDPH.[7] EA enables controlled sympathetic blockade, suitable for patients requiring haemodynamic stability.

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

Bupivacaine, a long-acting amide local anaesthetic, is used in epidural anaesthesia for sensory blockade with minimal motor impairment.8 EA efficacy improves by combining local anaesthetics with opioids. Fentanyl, a μ-opioid receptor agonist 75-125 times more potent than morphine, provides a rapid onset when administered epidurally.[9] This combination enhances block quality and reduces local anaesthetic dose, minimising toxicity.

Traditionally, monitoring the onset and effectiveness of an epidural block is based on subjective sensory and motor assessments or haemodynamic changes. However, these methods are imprecise. The perfusion index (PI) from pulse oximetry indicates peripheral perfusion. It reflects vasodilation resulting from the sympathetic blockade and may serve as a sensitive marker for early detection of successful epidural anaesthesia.[10] This study compared epidural anaesthesia using bupivacaine alone versus bupivacaine with fentanyl in elective hernia surgeries. The PI was evaluated using the mean arterial pressure (MAP) and heart rate (HR) to assess block onset and efficacy.

MATERIALS AND METHODS

A prospective, randomised, double-blind controlled study was conducted on 60 patients undergoing elective hernia surgeries at the Department of General Surgery, K.A.P. Viswanatham Government Medical College, Tiruchirappalli, between December 2018 and September 2020. Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was obtained from all the patients.

Inclusion and exclusion criteria

The study included patients aged 30–65 years, classified as American Society of Anesthesiologists (ASA) physical status I or II, and scheduled for elective hernia surgeries. Patients who refused to participate and those with contraindications to regional anaesthesia were excluded from the study.

Methods

The study population was randomly allocated to two groups of 30 patients each. Group B received 12 ml of 0.5% bupivacaine with 0.5 ml normal saline, whereas Group BF received 12 ml of 0.5% bupivacaine with 0.5 ml fentanyl (25μg). Patients fasted overnight and received intravenous metoclopramide and ranitidine 45 minutes before surgery. In the operating room, baseline HR, blood pressure (BP), oxygen saturation (SpO_2), and PI were recorded using a Masimo monitor, with the PI measured from the second toe.

Patients were positioned laterally for epidural anaesthesia at L1–L2 using an 18G Tuohy needle. The epidural space was identified using the loss-of-resistance technique, and a catheter was advanced to the T10–T11 region. A test dose of 3 ml of 1.5% lignocaine with epinephrine (1:200,000) ruled out intravascular or subarachnoid placement. Monitoring included haemodynamic parameters, PI, surgery duration, and adverse events such as hypotension, bradycardia, or tachycardia.

Statistical Analysis

Descriptive statistics were used in two-way tables, with categorical variables as frequencies/percentages and continuous variables as means with standard deviations. The chi-square test was used to assess differences between categorical variables, while the t-test was used to compare group means. Statistical significance was set at $p < 0.05$.

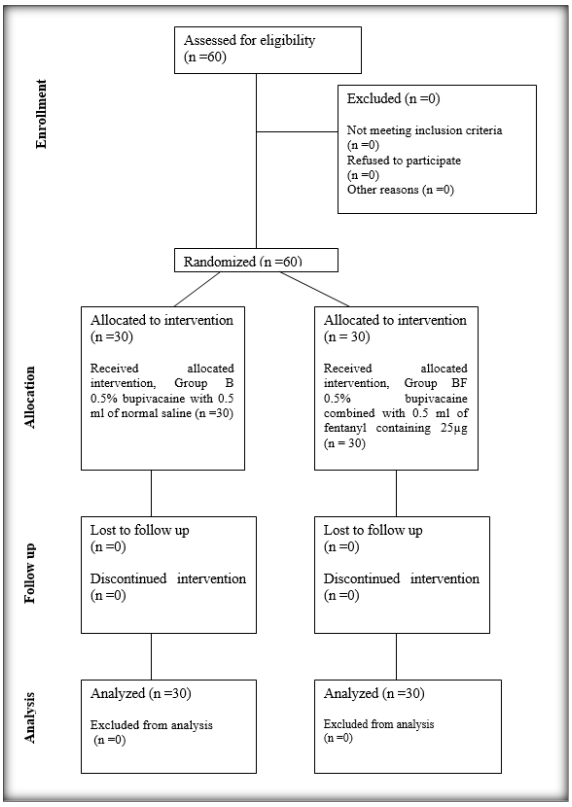

Figure 1: CONSORT flow diagram

RESULTS

The mean age was 40.07 ± 10.14 years in Group B and 42.27 ± 7.79 years in Group BF. The mean height was 165.37 ± 6.01 cm and 166.33 ± 6.13 cm, while the mean weight was 65.23 ± 6.30 kg and 65.80 ± 9.50 kg, with no significant differences between groups ($p > 0.05$) (Table 1).

Table 1: Demographic distribution between groups

	Group B	Group BF	P-value
Age (years)	40.07 ± 10.14	42.27 ± 7.79	0.35
Height (cm)	165.37 ± 6.01	166.33 ± 6.13	0.54
Weight (kg)	65.23 ± 6.30	65.80 ± 9.50	0.787

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

Group BF showed a significantly higher preoperative pulse rate (80.60 ± 9.52 bpm) than Group B (73.47 ± 13.56 bpm; p = 0.022). At 1 min, the pulse rate peaked in Group BF (101.07 ± 7.98 bpm) versus Group B (83.77 ± 10.89 bpm), showing a highly significant difference (p = 0.000). At 2 min, Group BF continued to have a significantly elevated pulse rate (101.63 ± 8.81 bpm vs. 96.67 ± 6.58 bpm; p = 0.016). No other time points showed significant differences (p > 0.05) (Figure 2).

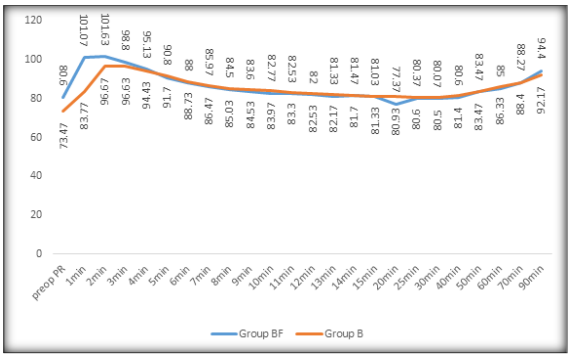

Figure 2: Mean pulse rate between groups

Preoperatively, there was no significant difference in systolic blood pressure (SBP) between Group BF (113.80 ± 9.10 mmHg) and Group B (113.93 ± 10.87 mmHg; p = 0.959). However, Group B demonstrated consistently higher SBP values than Group BF at multiple time points after administration. Significant differences were observed from 1 to 12 min (p < 0.001 to p = 0.007) (Figure 3).

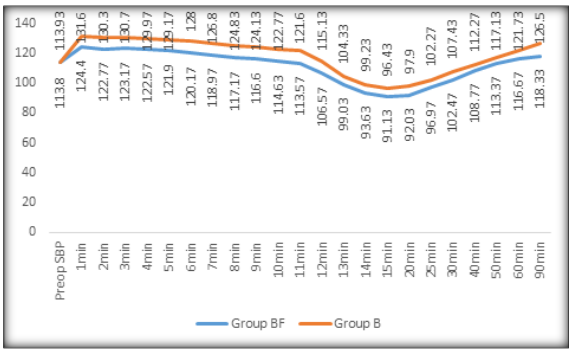

Figure 3: Systolic blood pressure between groups

The preoperative mean diastolic blood pressure was similar between Group BF (73.37 ± 7.18 mmHg) and Group B (74.77 ± 7.43 mmHg, p = 0.461). From 1 to 9 min post-administration, Group B consistently demonstrated significantly higher diastolic pressures than Group BF, with p-values ranging from 0.007 to 0.017. At 10 and 11 min, Group B continued to show higher values, but the difference was not significant (p = 0.067 and 0.094, respectively). From 12 to 25 min, the mean diastolic pressures in both groups gradually declined, with Group B maintaining marginally higher readings throughout. However, the differences during this period were insignificant (p > 0.05) (Figure 4).

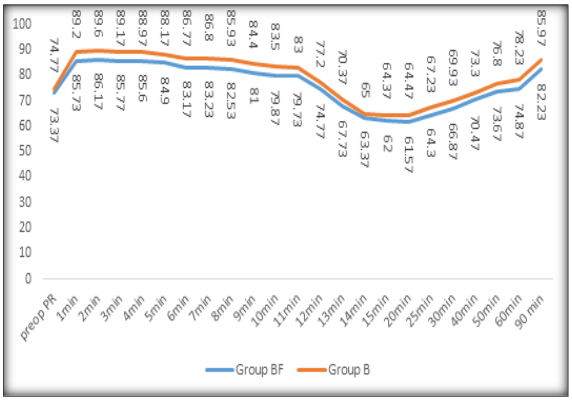

Figure 4: Diastolic blood pressure between groups

Group B demonstrated significantly higher MAP values than Group BF from 1 to 9 min (p ≤ 0.001), and again at 10 min (96.53 ± 5.95 vs. 91.40 ± 6.43 mmHg; p = 0.002) and 11 min (95.83 ± 6.31 vs. 90.97 ± 6.26 mmHg; p = 0.004). Additional significant differences were observed at 15 min (p = 0.027), 20 min (p = 0.007), and 25 min (p = 0.013), confirming greater MAP stability in Group BF (p < 0.05) (Figure 5).

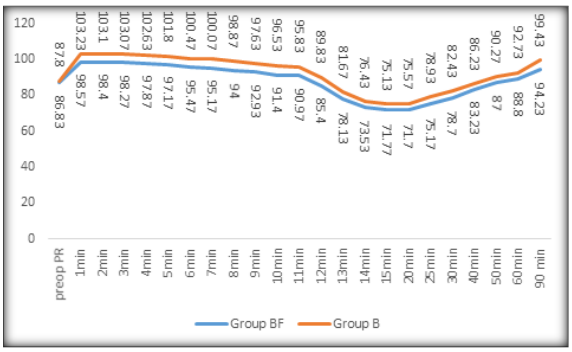

Figure 5: MAP between groups

At 8 min, the PI was significantly higher in Group BF (5.49 ± 4.50) than in Group B (3.02 ± 1.24, p = 0.005). This continued from 9 to 13 min, with Group BF maintaining consistently elevated PI values, reaching a peak at 12 min (13.60 ± 2.16 vs. 7.42 ± 4.49; p < 0.001). A significant difference was also observed at 14 min (13.04 ± 2.05 vs. 11.78 ± 2.62; p = 0.042), suggesting an earlier onset of sympathetic blockade in the bupivacaine-fentanyl group (p < 0.05) (Figure 6).

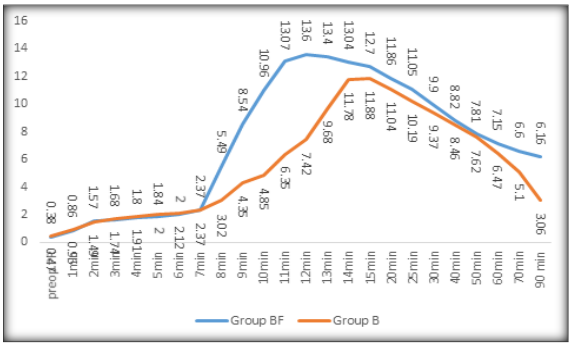

Figure 6: PI between groups

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

The mean duration of analgesia in Group B was 98.4 ± 10.21 min, whereas in Group BF, it was 123.5 ± 13.24 min, which was a significant difference between groups ($p < 0.0001$) (Table 2).

Table 2: Duration of analgesia between groups

Group	Mean ± SD (min)	P-value
Group B	98.4 ± 10.21	<0.0001
Group BF	123.5 ± 13.24	

In Group B, nausea was reported in two patients (10%), while in Group BF, it was observed in three patients (10%). Vomiting and urinary retention were not reported in either of the groups. Pruritus occurred in 10 (30%) patients in Group BF and none in Group B. Hypotension was noted in three (10%) patients in Group B and none in Group BF (Table 3).

Table 3: Incidence of side effects between groups

Side effect	Group B (N, %)	Group BF (N, %)
Nausea	2 (10%)	3 (10%)
Vomiting	0	0
Urinary Retention	0	0
Pruritus	0	10 (30%)
Hypotension	3 (10%)	0 (0%)

DISCUSSION

In our study, the demographics were comparable between the groups, with no significant differences ($p > 0.05$). Similarly, a study done by Ocak found that age ($p=0.146$), height ($p=0.133$), and weight ($p=0.656$) had no significant difference in terms of the maximum level of the sensory block between groups.[11]

In our study, both groups showed an increase in pulse rate following drug administration, peaking at 4 min (100 bpm in Group B and 103.5 bpm in Group BF), followed by a gradual decline. Throughout the observation period, Group BF maintained slightly higher pulse rates than Group Similarly, Salgaonkar et al. found in a retrospective comparison involving 100 patients receiving bupivacaine (7.5 mg or 10 mg) combined with (25 µg) fentanyl, heart rate monitoring at five-minute intervals revealed an early elevation of approximately 4–5 beats per minute in both groups.[12]

In our study, preoperative SBP was comparable between the groups ($p = 0.959$). However, Group B exhibited significantly higher SBP from 1 to 12 min and again at 14, 15, 20, and 25 min post-administration ($p < 0.05$), indicating greater haemodynamic fluctuations than Group BF. Similarly, Kararmaz et al. SBP was measured every 3 min for the first 15 min after spinal blockade. The bupivacaine with fentanyl group exhibited less pronounced SBP drops and maintained more haemodynamic stability than bupivacaine alone throughout the early minutes ($p < 0.05$). Group B had greater SBP fluctuations early on, whereas fentanyl co-administration stabilised SBP.[13]

In our study, the preoperative DBP was similar ($p = 0.461$). Group B showed significantly higher DBP from 1 to 9 min ($p = 0.007$–0.017). Differences were not significant from 10 to 25 min ($p > 0.05$). In contrast, Gurbet et al. found that diastolic blood pressure was lower in the bupivacaine + fentanyl group starting at 5 min post-administration, with significant differences ($p < 0.001$) at 5, 10, 15, and 20 min, and continuing until 1 h postoperatively, contrasting with baseline measurements ($p = 0.067$).[14] Ocak found that Baseline DBP was comparable, and after the block, DBP remained similar between the bupivacaine alone and bupivacaine with fentanyl groups at all measured intervals ($p > 0.05$), including early intraoperative periods. Group B showed transient early DBP elevation, while other studies varied in whether DBP changed significantly with fentanyl addition.[11]

In our study, the preoperative MAP was comparable between the groups ($p = 0.513$). Group B exhibited significantly higher MAP from 1 to 11 min and again at 15, 20, and 25 min ($p < 0.05$), with no significant differences between 12 and 14 min. Similarly, Neik et al. reported early reductions in MAP with the bupivacaine–fentanyl combination, followed by haemodynamic stabilisation later in the postoperative period, using a >20% rise in MAP from baseline to guide fentanyl administration. Early higher MAP in Group B was consistent with showing initial drops and later stabilisation in the fentanyl groups.[15]

In our study, the preoperative PI was not significantly different ($p = 0.111$). From 8 to 14 min, Group BF had a significantly higher PI ($p < 0.05$). From 15 to 25 min, the differences were not significant. Similarly, a study done by Toyama et al. found that in parturients receiving spinal anaesthesia with bupivacaine and fentanyl, a rise in PI within 8 to 15 min indicated early sympathetic blockade.16 Vedagiri et al. showed that adding fentanyl (50–100 µg) to low-dose bupivacaine led to faster analgesic onset and earlier rises in PI within the first 10 min. PI elevation in the fentanyl group aligned with previous findings indicating early sympathetic blockade onset.[17]

In our study, the mean duration of analgesia was significantly longer in Group BF (123.5 ± 13.24 min) than in Group B (98.4 ± 10.21 min, $p<0.0001$). Similarly, Lee et al. found that Group B showed

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

longer analgesia (120 (90-120) min) than Group A (75 (75-105) min) (p=0.013).[18] Scott et al. showed excellent or good pain relief in 82.6% of assessments, confirming extended and effective analgesia in a general surgical population. Fentanyl extended the duration of analgesia significantly, supporting prior studies that demonstrated prolonged pain relief with its use.[19]

In our study, nausea occurred equally (10%) in both groups. Pruritus was reported only in Group BF (30%), and hypotension occurred only in Group B (10%) patients. Vomiting and urinary retention were not reported in either of the groups. Similarly, Kılıçkaya et al. found that in the fentanyl with bupivacaine group, nausea and, in contrast, vomiting occurred in seven patients, urinary retention in one patient, and pruritus in four patients compared to the morphine group.20 Guo et al. found in a meta-analysis of epidural bupivacaine with fentanyl combinations during surgical procedures reported the following side effect incidences, pruritus (29.9 ± 24.5%), nausea (7.6 ± 5.6%), and hypotension (11.7 ± 11%). Pruritus was higher with fentanyl use, while nausea was similar in both groups, aligning with previous studies showing fentanyl's common side effects.[21]

The addition of fentanyl to bupivacaine resulted in prolonged analgesia and greater haemodynamic stability, as seen in more stable SBP, MAP, and DBP than bupivacaine alone. An early increase in the PI in the fentanyl group reflected a faster onset of sympathetic blockade. Side effects such as pruritus were more frequent with fentanyl, but nausea and hypotension remained minimal and comparable between both groups.

Limitations

The small sample size of this single-centre study may limit its generalisability. PI monitoring is restricted, potentially underestimating systemic perfusion trends. Additionally, the short follow-up duration, absence of long-term outcomes, and exclusion of high-risk patients restrict the broader applicability of the findings.

CONCLUSION

The addition of fentanyl to bupivacaine prolonged the duration of analgesia and demonstrated an earlier increase in PI, indicating a faster sympathetic blockade. Group BF maintained greater haemodynamic stability with lower fluctuations in systolic, diastolic, and MAP, whereas Group B exhibited higher early intraoperative blood pressure changes. Group BF showed higher pulse rates and more pruritus in the fentanyl group, while nausea and hypotension were similar between the groups. Overall, the PI proved to be a sensitive and noninvasive tool for assessing the onset of epidural block. The combination of bupivacaine and fentanyl offers superior efficacy and clinical advantages in epidural anaesthesia.

REFERENCES

1. Larson CP. Miller's Anesthesia, 7th ed. Anesth Analg 2010;110:263–5. https://doi.org/10.1213/ane.0b013e3181b7c799.
2. Pasero C, McCaffery M. Pain Assessment and Pharmacologic Management. St. Louis: Mosby; 2011.https://clinicalgate.com/pain-management-5/?utm_source=chatgpt.com.
3. Johnson C. The pain pioneer: The visionary approach of John Bonica. Health Rising 2015. https://www.healthrising.org/blog/2015/07/05/the-pain-pioneer-the-visionary-approach-of-john-bonica/
4. Folino TB, Mahboobi SK. Regional anaesthetic blocks. Stat Pearls, Treasure Island (FL): Stat Pearls Publishing; 2025. https://www.ncbi.nlm.nih.gov/books/NBK563238/
5. Hutton M, Brull R, Macfarlane AJR. Regional anaesthesia and outcomes. BJA Educ 2018; 18:52 -6. https://doi.org/10.1016/j.bjae.2017.10.002.
6. Avila Hernandez AN, Hendrix JM. Epidural anaesthesia. Stat Pearls, Treasure Island (FL): Stat Pearls Publishing; 2025. https://pmc.ncbi.nlm.nih.gov/articles/PMC7807931/
7. Bakshi SG, Gehdoo RSP. Incidence and management of post-dural puncture headache following spinal anaesthesia and accidental dural puncture from a non-obstetric hospital: A retrospective analysis. Indian J Anaesth 2018; 62:881–6. https://doi.org/10.4103/ija.IJA_354_18
8. Parashar P, Singh A, Sharma MK, Raval DL. Comparison between isobaric levobupivacaine 0.5% and hyperbaric bupivacaine 0.5% in spinal anaesthesia in lower limb surgeries and lower abdominal surgeries in adult patients. Int J Res Med Sci 2021; 9:418. https://doi.org/10.18203/2320-6012.ijrms20210417.
9. Swain A, Nag DS, Sahu S, Samaddar DP. Adjuvants to local anaesthetics: Current understanding and future trends. World J Clin Cases 2017; 5:307–23. https://doi.org/10.12998/wjcc.v5.i8.307.
10. Ginosar Y, Weiniger CF, Meroz Y, Kurz V, Bdolah-Abram T, Babchenko A, et al. Pulse oximeter perfusion index as an early indicator of sympathectomy after epidural anaesthesia. Acta Anaesthesiol Scand 2009; 53:1018 26. https://doi.org/10.1111/j.1399-6576.2009.01968.x.Ocak İ. Hemodynamic changes and recovery in unilateral spinal anaesthesia using bupivacaine and bupivacaine + fentanyl combinations in outpatient inguinal hernia surgery. Florence Nightingale J Med 2022; 8:175 181. https://journalmeddbu.com/full-text/277?utm_source=chatgpt.com
11. Ocak İ. Hemodynamic changes and recovery in unilateral spinal anesthesia using bupivacaine and bupivacaine + fentanyl combinations in outpatient inguinal hernia surgery. Florence Nightingale J Med 2022; 8:175–181.https://journalmeddbu.com/full-text/277?utm_source=chatgpt.com
12. Salgaonkar S, Oak S, Darshni D, Tendolkar BA. Low-dose bupivacaine with fentanyl for spinal anaesthesia during ambulatory inguinal hernia repair surgery: a comparison between 7.5 and 10 mg of 0.5% hyperbaric bupivacaine—A retrospective study. Res Inno Anesth 2018;3(1):8–12. https://doi.org/10.5005/jp-journals-10049-0025
13. Gurbet A, Turker G, Girgin NK, Aksu H, Bahtiyar NH. Combination of ultra-low dose bupivacaine and fentanyl for spinal anaesthesia in outpatient anorectal surgery. J Int Med Res 2008; 36:964 70. https://doi.org/10.1177/147323000803600512.
14. Kararmaz A, Kaya S, Turhanoglu S, Ozyilmaz MA. Low-dose bupivacaine-fentanyl spinal anaesthesia for transurethral prostatectomy: Bupivacaine-fentanyl for TURP. Anaesthesia 2003; 58:526–30. https://doi.org/10.1046/j.1365-2044.2003.03153.x.
15. Neik S, John M, Kapil K, Roj T. Comparison between the effect of 0.0625% bupivacaine with 2% fentanyl and 0.125% bupivacaine with 2% fentanyl epidural infusion on haemodynamic parameters in infra-umbilical surgeries. J Anesth Clin Res 2022; 13:1 10. https://doi.org/10.35248/2155-6148.22.13.1085

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

16. Toyama S, Kakumoto M, Morioka M, Matsuoka K, Omatsu H, Tagaito Y, et al. Perfusion index derived from a pulse oximeter can predict the incidence of hypotension during spinal anaesthesia for Caesarean delivery. Br J Anaesth 2013; 111:235 41. https://doi.org/10.1093/bja/aet058.
17. Vedagiri Sai R, Singh SI, Qasem F, Nguyen D, Dhir S, Marmai K, et al. Onset of labour epidural analgesia with low-dose bupivacaine and different doses of fentanyl. Anaesthesia 2017; 72:1371–8. https://doi.org/10.1111/anae.14000.
18. Lee BB, Ngan Kee WD, Hung VY, Wong EL. Combined spinal-epidural analgesia in labour: comparison of two doses of intrathecal bupivacaine with fentanyl. Br J Anaesth 1999; 83:868 71. https://doi.org/10.1093/bja/83.6.868.
19. Scott DA, Beilby DS, McClymont C. Postoperative analgesia using epidural infusions of fentanyl with bupivacaine. A prospective analysis of 1,014 patients. Anesthesiology 1995; 83:727–37. https://doi.org/10.1097/00000542-199510000-00012.
20. Kılıçkaya R, Şahin T, Güleç E, Balcı M, Balcı F. Comparison of the effects of intrathecal fentanyl and intrathecal morphine on postoperative pain after inguinal hernia repair. Cukurova Med J 2018; 43:835–839.https://doi.org/10.17826/cumj.358546.
21. Guo S, Li B, Gao C, Tian Y. Epidural analgesia with bupivacaine and fentanyl versus ropivacaine and fentanyl for pain relief in labor: A meta-analysis. Medicine (Baltimore) 2015;94: e880. https://doi.org/10.1097/md.0000000000000880.

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