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"A Comparison Of The Effect Of Fractionated And Bolus Dose Injection On Spinal Anaesthesia In Lower Abdominal, Lower Limb And Perineal Surgeries: A Hospital Based Prospective Cross Sectional Study"

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Abstract:
Background*: Spinal anaesthesia is widely used for lower abdominal, lower limb and perineal surgeries because of its rapid onset, reliability and cost effectiveness. However, administration of intrathecal local anaesthetic as a single bolus dose may cause sudden sympathetic blockade resulting in haemodynamic instability. Fractionated intrathecal administration of local anaesthetic has been proposed to produce a gradual onset of block with improved haemodynamic stability and prolonged analgesia.*
Materials and Methods *This hospital-based prospective cross-sectional study included 90 patients aged 18–60 years belonging to ASA physical status I and II undergoing lower abdominal, lower limb and perineal surgeries under spinal anaesthesia. Patients were randomly divided into two equal groups. Group B received a single bolus intrathecal injection of 0.5% hyperbaric bupivacaine with buprenorphine, whereas Group F received the same total dose administered in a fractionated manner with a time interval of 45 seconds. Heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure and oxygen saturation were monitored intraoperatively. Sensory and motor blockade were assessed at regular intervals. Statistical analysis was performed and a p value <0.05 was considered statistically significant.*
Results*: Baseline demographic characteristics were comparable between the groups with no significant difference in age distribution (p = 0.54). The mean onset of sensory block was 1.49 ± 0.66 minutes in the bolus group and 1.00 ± 0.00 minutes in the fractionated group (p = 0.39). The duration of sensory block was significantly longer in the fractionated group (167.51 ± 16.59 minutes) compared with the bolus group (117.13 ± 21.04 minutes) (p = 0.04). The mean time to achieve Bromage score 3 was comparable between the groups. However, the duration of motor block was significantly prolonged in the fractionated group (187.71 ± 16.45 minutes) compared with the bolus group (130.31 ± 21.10 minutes) (p = 0.03). Haemodynamic parameters including heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure remained comparable between the groups throughout most intraoperative periods.*
Conclusion: *Fractionated intrathecal administration of hyperbaric bupivacaine with buprenorphine provides a significantly longer duration of sensory and motor blockade compared with the conventional bolus technique without causing significant haemodynamic instability. Therefore, the fractionated dose technique appears to be a safe and effective alternative to single bolus spinal anaesthesia for lower abdominal, lower limb and perineal surgeries.*
Keyword: *Intrathecal Spinal anaesthesia, Fractionated dose, Bolus dose, Bupivacaine, Buprenorphine, Haemodynamic stability.*

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I. Introduction

Spinal anaesthesia is a commonly employed regional anaesthetic technique for lower abdominal, lower limb and perineal surgeries because of its rapid onset, reliability and cost effectiveness. However, administration of intrathecal local anaesthetic as a single bolus dose may result in sudden sympathetic blockade leading to haemodynamic instability. Fractionated intrathecal administration of local anaesthetic has been suggested to provide a gradual onset of block with improved haemodynamic stability. This study aims to compare the effect of fractionated and bolus dose injection of hyperbaric bupivacaine with buprenorphine on sensory blockade and haemodynamic changes.

II. Material And Methods

After getting permission from Institutional Ethics Committee, Department of Anesthesiology, Akash institute of medical sciences and research centre, Devanahalli, Bangalore, an informed consent obtained from the patients. The present study was conducted prospectively in 30 patients in the age group of 18–60 years of either sex of the American Society of Anesthesiologists (ASA), Physical status Class I and II scheduled to undergo elective surgery under general anesthesia

Study Design: A Hospital based prospective cross sectional study.

Study Location: This was a tertiary care teaching hospital based study done in Department of Anaesthesiology, at Akash Institute of Medical Sciences & Research Centre, Devanahalli, Bengaluru, Karnataka.

Study Duration: November 2024 to April 2025.

Sample size: 90 patients.

Sample size calculation: The sample size was estimated on the basis of a single proportion design. The target population from which we randomly selected our sample was considered 200. We assumed that the confidence interval of 10% and confidencelevel of 95%. The sample size actually obtained for this study was 45 patients for each group. We planned to include 90 patients (Group B – Bolus dose, Group F – fractionated dose of 45 patients for each group)

Subjects & selection method The study population was drawn from the patients who were posted for elective surgeries under General Anaesthesia in Akash Institute of Medical Sciences & Research Centre from November 2024 to April 2025. Patients were divided into two groups (each group had 15 patients).
Group B (N=45 patients) -Bolus dose each patient;
Group F (N=45 patients) – Fractionated dose to each patient.

Inclusion criteria:
1. Patients posted for lower abdominal,lower limb and perineal surgeries.
2.American society of anesthesiologists (ASA) physical status I and II
3.Age group:18-60yrs
4.Patient giving written informed consent for the study.

Exclusion criteria:
1.Aged between <18 – >60 years
2. obesity
3. Pregnancy
4. H/o drug abuse
5. Patients giving written informed consent.

Procedure methodology:

After obtaining clearance from the Institutional Ethics Committee, the patients were enrolled for the study as per inclusion criteria after obtaining written informed consent. Study was conducted in Akash Institute of Medical Sciences and Research Center, Devanahalli, Bangalore, Karnataka. Detailed pre-anesthetic evaluation was done. Patients were graded according to ASA classification.

American society of anaesthesiologists (ASA) grading [4]
Grade 1 – Normal healthy patient.
Grade 2 - Mild to moderate systemic disease that is well controlled.
Grade 3 – Severe systemic disease of at least one organ system.
Grade 4 – Severe systemic end stage disease of at least one organ system that is life threatening.
Grade 5 – Moribund patient who has little chance of survival.
Grade 6 – Declared brain dead patient.

Patient in lateral position,with 25G Quincke's needle 3ml of 0.5%inj.bupivacaine(13.5mg) and adjuvant inj.buprenorphine(90mcg) administered.Patients monitored with respect to Group B received a single bolus intrathecal injection of 0.5% hyperbaric bupivacaine with buprenorphine, while Group F received the same total dose administered in a fractionated manner with a fixed time interval of 45 seconds.heart rate (HR), blood pressure

(BP) and oxygen saturation (SpO2) and motor and sensory blockade levels every 5 mins, 10 mins, 15 mins, 20 mins, 40 mins and later every 20 mins intraoperatively and followed by post operative monitored.

Statistical analysis

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software and Epi-info version 7.2.1 (CDC Atlanta) software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Normality of the continuous data, was tested by Kolmogorov–Smirnov test and the Shapiro–Wilk test. Independent t test was used as test of significance to identify the mean difference between two quantitative variables. Mann Whitney U test was used for Non parametric data between two groups. Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as Line diagram, bar diagram p value (Probability that the result is true) of <0.05was considered as significant after assuming all the rules of statistical tests.

III. Result

The study was conducted in the Department of Anesthesiology, Akash Institute of Medical Sciences and Research Center, Devanahalli, Bangalore, Karnataka from March, 2024, to November, 2024. The study population included 30 patients aged between 18 and 60 years belonging to ASA class I and II undergoing elective surgeries under general anesthesia. The participants were the patients who satisfied the inclusion criteria.

Comparison Of Heart Rate Between Group B & Group F

Table 1: Heart Rate (Bpm)Among The 2 Groups

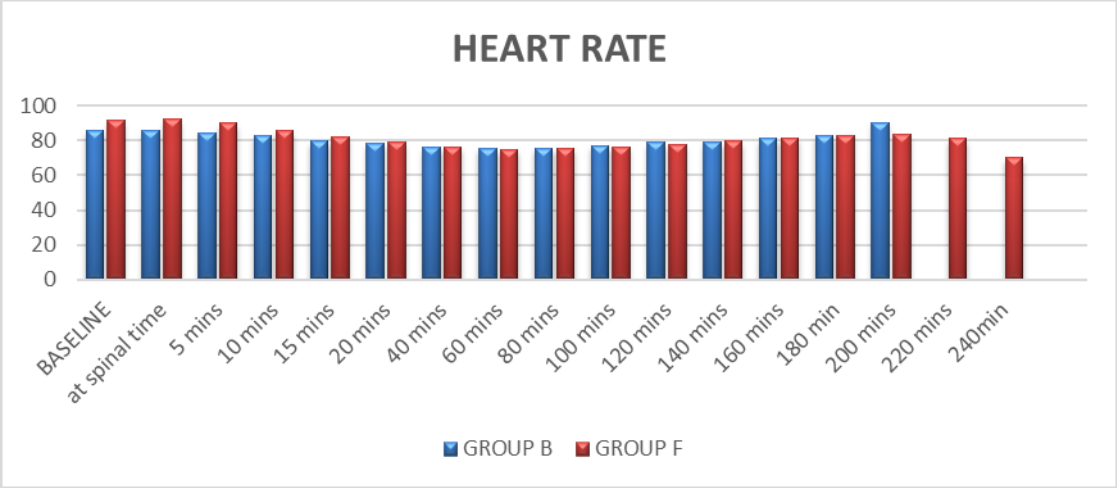
Time Point	Group B HR (Mean ± SD)	Group F HR (Mean ± SD)	p-value
Baseline	85.75 ± 14.83	91.50 ± 14.74	0.68
At spinal time	85.73 ± 15.30	92.22 ± 15.96	0.67
5 min	84.40 ± 16.00	90.13 ± 17.17	0.69
10 min	83.00 ± 15.13	85.52 ± 18.02	0.86
15 min	79.70 ± 14.83	82.22 ± 16.14	0.84
20 min	78.17 ± 12.95	79.45 ± 15.15	0.90
40 min	76.08 ± 12.31	76.47 ± 13.98	0.97
60 min	75.60 ± 12.25	75.00 ± 14.38	0.96
80 min	75.80 ± 11.95	75.72 ± 13.11	0.99
100 min	77.35 ± 11.51	76.47 ± 13.12	0.92
120 min	78.90 ± 11.49	77.79 ± 12.67	0.90
140 min	79.24 ± 12.81	79.90 ± 11.81	0.94
160 min	81.26 ± 13.73	81.47 ± 11.59	0.98
180 min	83.00 ± 13.00	83.22 ± 10.79	0.98
200 min	90.50 ± 2.10	83.86 ± 10.34	0.43
220 min	—	81.33 ± 15.27	—
240 min	—	70	—

The comparison of heart rate at various intraoperative time intervals between Group B and Group F is presented in Table 1.

Statistical analysis using student's unpaired t-test demonstrated that there was no significant difference ($p>0.05$) in the heart rate distribution between group B and group F, indicating that both study groups were comparable with respect to baseline heart rate.At baseline, the mean heart rate was 85.75 ± 14.83 beats per minute in Group B and 91.50 ± 14.74 beats per minute in Group F. The difference between the two groups was not statistically significant ($p = 0.68$), indicating comparable baseline heart rates.

At the time of spinal anaesthesia, heart rate showed a mild reduction in both groups. However, the inter-group difference between Group B (85.73 ± 15.30 bpm) and Group F (92.22 ± 15.96 bpm) remained statistically not significant ($p = 0.67$).During the early intraoperative period (5, 10, 15, and 20 minutes), a gradual decline in heart rate was observed in both groups. Inter-group comparison at 5 minutes ($p = 0.69$), 10 minutes ($p = 0.86$), 15 minutes ($p = 0.84$), and 20 minutes ($p = 0.90$) showed no statistically significant difference between the groups.At 40 and 60 minutes, heart rate values stabilized in both groups, and the difference between Group B and Group F was not statistically significant ($p = 0.97$ and $p = 0.96$, respectively)

From 80 to 160 minutes, heart rate remained relatively same with a gradual upward trend toward baseline values in both groups. Inter-group comparison at 80 minutes ($p = 0.99$), 100 minutes ($p = 0.92$), 120 minutes ($p = 0.90$), 140 minutes ($p = 0.94$), and 160 minutes ($p = 0.98$) revealed no statistically significant difference.At 180 minutes, the mean heart rate was comparable between Group B (83.00 ± 13.00 bpm) and Group F (83.22 ± 10.79 bpm), with no statistically significant difference ($p = 0.98$).At 200 minutes, although Group B showed a higher mean heart rate compared to Group F, the difference was not statistically significant ($p = 0.43$).At 220 and 240 minutes, heart rate values were available only for Group F; therefore, inter-group statistical comparison is not applicable.



Comparison Of Mean Arterial Pressure Of Group B And Group F

Table 2: Variation in MAP among the 2 groups

Time Point	Group B MAP (Mean ± SD)	Group F MAP (Mean ± SD)	p-value
Baseline	100.08 ± 12.63	106.27 ± 15.25	0.64
At spinal time	96.15 ± 13.18	103.84 ± 15.19	0.63
5 min	91.51 ± 12.61	92.31 ± 12.42	0.94
10 min	87.02 ± 12.11	89.61 ± 13.69	0.80
15 min	85.88 ± 11.30	86.79 ± 12.91	0.92
20 min	83.57 ± 10.68	85.18 ± 11.97	0.86
40 min	83.00 ± 10.70	84.84 ± 11.61	0.85
60 min	84.08 ± 8.85	84.09 ± 10.80	0.99
80 min	85.33 ± 7.74	86.68 ± 11.74	0.88
100 min	85.88 ± 8.04	88.31 ± 11.63	0.77
120 min	88.47 ± 7.53	89.45 ± 10.26	0.90
140 min	89.13 ± 7.77	92.29 ± 11.03	0.70
160 min	93.26 ± 8.59	94.77 ± 9.06	0.86
180 min	101.00 ± 6.90	97.95 ± 8.93	0.67
200 min	99.00	98.00 ± 7.94	—
240 min	----	105	----

The comparison of mean arterial pressure (MAP) at various intraoperative time intervals between Group B and Group F is presented in Table 2.

Statistical analysis using student's unpaired t-test demonstrated that there was no significant difference ($p>0.05$) in the mean arterial pressure distribution between group B and group F, indicating that both study groups were comparable with respect to baseline mean arterial pressure.At baseline, the mean arterial pressure was 100.08 ± 12.63 mmHg in Group B and 106.27 ±15.25 mmHg in Group F. The difference between the two groups was not statistically significant ($p = 0.64$), indicating comparable baseline MAP values.

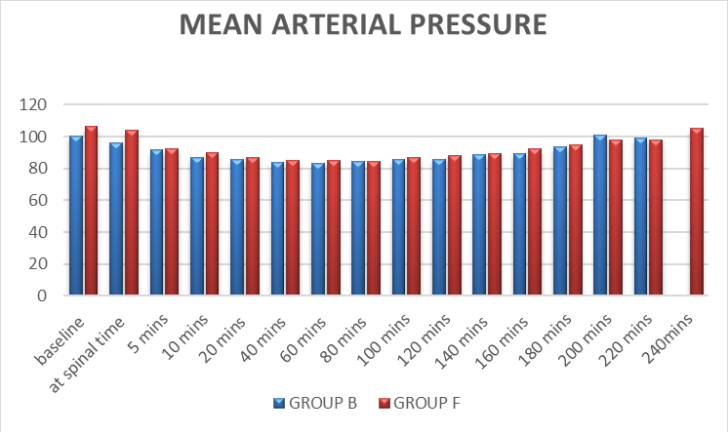
At the time of spinal anesthesia, MAP showed a mild reduction in both groups. However, the inter-group difference between Group B (96.15 ± 13.18 mmHg) and Group F (103.84 ± 15.19 mmHg) was not statistically significant ($p = 0.63$).

During the early intraoperative period (5, 10, 15, and 20 minutes), MAP demonstrated a gradual decline in both groups. Inter-group comparison at 5 minutes ($p = 0.94$), 10 minutes ($p = 0.80$), 15 minutes ($p = 0.92$), and 20 minutes ($p = 0.86$) showed no statistically significant difference.

At 40 and 60 minutes, MAP values were comparable between Group B and Group F, with no statistically significant inter-group difference ($p = 0.85$ and $p = 0.99$, respectively).

From 80 to 160 minutes, MAP values gradually increased toward baseline levels in both groups. Inter-group comparison at 80 minutes ($p = 0.88$), 100 minutes ($p = 0.77$), 120 minutes ($p = 0.90$), 140 minutes ($p = 0.70$), and 160 minutes ($p = 0.86$) revealed no statistically significant difference.At 180 minutes, MAP values were comparable between Group B (101.00 ± 6.90 mmHg) and Group F (97.95 ± 8.93 mmHg), with no statistically significant difference ($p = 0.67$).

At 200 minutes, statistical comparison could not be performed due to non-availability of standard deviation data in Group B. At 220 and 240 minutes, MAP values were available only for Group F; therefore, inter-group statistical comparison was not applicable.



Comparison Of Sensory Block Onset &Duration of Group B And Group F.

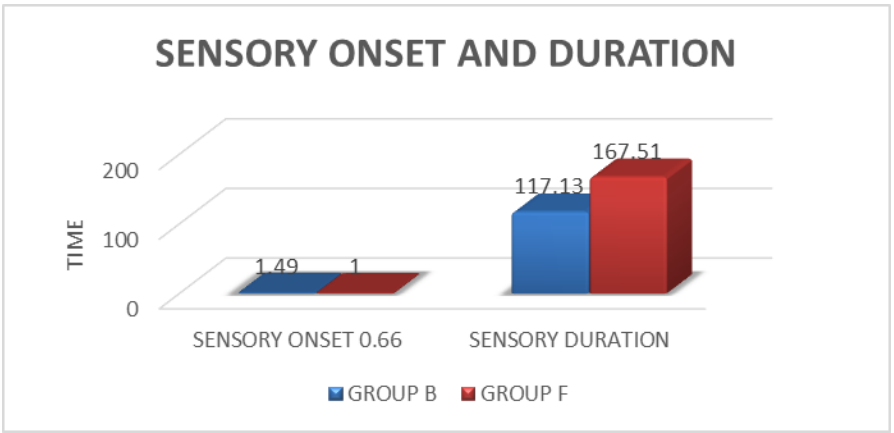
Table 3: Sensory Block Onset &Duration Among 2 Groups

Clinical Parameter	Group B (Mean ± SD)	Group F (Mean ± SD)	p-value
Sensory onset (min)	1.49 ± 0.66	1.00 ± 0.00	0.39
Sensory duration (min)	117.13 ± 21.04	167.51 ± 16.59	**0.04**

The comparison of sensory block characteristics between Group B and Group F is shown in Table 3.

The mean time for onset of sensory block was 1.49 ± 0.66 minutes in Group B and 1.00 ±0.00minutes in group F. On statistical analysis using Student's unpaired t-test, the difference in sensory onset time between the two groups was found to be statistically not significant (p = 0.39).

The mean duration of sensory block was 117.13 ± 21.04 minutes in Group B, whereas it was 167.51 ± 16.59 minutes in Group F. The difference in sensory block duration between the two groups was found to be statistically significant (p = 0.04), with Group F showing a significantly prolonged duration of sensory block compared to Group B.



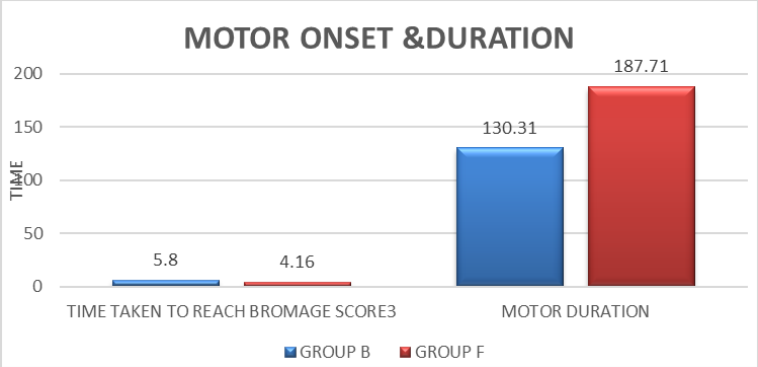
Comparison Of Motor Block Onset &Durationof Group B And Group F.

Table 4: Motor Block Onset & Duration Among 2 Groups

Clinical Parameter	Group B (Mean ± SD)	Group F (Mean ± SD)	p-value
Time taken to reach Bromage score 3 (min)	5.80 ± 1.45	4.16 ± 0.99	0.28
Motor block duration (min)	130.31 ± 21.10	187.71 ± 16.45	**0.03**

The comparison of motor block characteristics between Group B and Group F is presented in Table 4

The mean time taken to achieve Bromage score 3 was 5.80 ± 1.45 minutes in Group B and 4.16 ± 0.99 minutes in Group F. On statistical analysis using Student's unpaired t-test, the difference in time taken to reach Bromage score 3 between the two groups was found to be statistically not significant (p = 0.28). The mean duration of motor block was 130.31 ± 21.10 minutes in Group B, whereas it was 187.71 ± 16.45 minutes in Group F. This difference in motor block duration between the two groups was found to be statistically significant (p = 0.03), indicating a prolonged duration of motor block in Group F.



IV. Discussion

Spinal anaesthesia is widely used for lower abdominal, lower limb and perineal surgeries because of its rapid onset, reliable neural blockade and favourable recovery profile. However, haemodynamic instability such as hypotension and bradycardia remains a common concern. The present study compared the clinical efficacy and haemodynamic stability of bolus intrathecal administration (Group B) and fractionated intrathecal administration (Group F) of hyperbaric bupivacaine with buprenorphine.

In the present study, baseline demographic characteristics were comparable between the two groups, with no statistically significant difference in age distribution ($p = 0.54$). This ensured adequate homogeneity between the groups and minimized confounding factors influencing spinal block characteristics and haemodynamic responses. Similar demographic comparability has been reported in studies by Badheka et al. and Srivastava et al.With regard to haemodynamic parameters, heart rate remained comparable between the two groups throughout the intraoperative period ($p > 0.05$). A mild reduction in heart rate was observed following spinal anaesthesia in both groups, which is expected due to sympathetic blockade. Similar observations were reported by Badheka et al. and Liu et al., who also found no significant difference in heart rate trends between bolus and fractionated intrathecal techniques.

Mean arterial pressure was comparable between the groups ($p > 0.05$). Both parameters showed a gradual decline followed by recovery toward baseline values during the intraoperative period. These findings are consistent with studies by Srivastava et al. and Nugroho et al., which demonstrated stable haemodynamic parameters with fractionated spinal anaesthesia.

Regarding sensory blockade, the onset of sensory block was rapid and comparable between the groups, with Group B showing a mean onset of 1.49 ± 0.66 minutes and Group F 1.00 ± 0.00 minutes ($p = 0.39$). However, the duration of sensory block was significantly longer in the fractionated group (167.51 ± 16.59 minutes) compared with the bolus group (117.13 ± 21.04 minutes) ($p = 0.04$). Prolonged sensory blockade is beneficial for longer surgical procedures and postoperative analgesia. Similar results have been reported by Arulpari et al. and Ravindran et al., who suggested that fractionated dosing improves drug spread within the cerebrospinal fluid.

In terms of motor blockade, the time required to achieve Bromage score 3 was slightly shorter in Group F, although the difference was not statistically significant ($p = 0.28$). However, the duration of motor block was significantly prolonged in the fractionated group (187.71 ± 16.45 minutes) compared with the bolus group (130.31 ± 21.10 minutes) ($p = 0.03$). These findings are consistent with studies by Singh et al. and Arora et al., which demonstrated prolonged motor blockade with fractionated spinal techniques.

The incidence of adverse effects was low in both groups. Hypotension was observed more frequently in the bolus group, whereas no clinically significant bradycardia, respiratory depression, pruritus, or neurological complications were observed in either group. Nausea and vomiting occurred in only one patient in each group and responded to standard antiemetic therapy. These findings support the safety profile of both techniques.

Overall, the results of the present study suggest that fractionated intrathecal administration provides comparable haemodynamic stability while producing significantly prolonged sensory and motor blockade, making it a useful alternative technique for spinal anaesthesia.

V. Conclusion

Fractionated intrathecal administration of hyperbaric bupivacaine with buprenorphine provides a significantly longer duration of sensory and motor blockade compared with the conventional bolus technique, without causing significant haemodynamic instability. Therefore, the fractionated dose technique appears to be a safe and effective alternative to single bolus spinal anaesthesia, particularly in patients where maintaining haemodynamic stability and prolonged postoperative analgesia are desirable.

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