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Expert Opinion Article

Spinal Anesthesia using Isobaric Ropivacaine with Fentanyl Versus Spinal Anesthesia using Isobaric Ropivacaine with Dexmedetomidine for Lower Abdominal Surgeries: A Prospective Observational Study

Dr. Ambreen Ashraf Lone[1], Dr. Rehana Nazir[2], Dr. Sheikh Irshad Ahmad[3], Dr. Basina Qayoom[4], Dr. Aaqib Suhail Mir[5] Dr. Mehreen Meer[6*]

[1]Department of Anaesthesiology, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, India Email ID: ambreenashraf992@gmail.com
[2]Department of Anaesthesiology, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, India
Email ID: imrehananazir786@gmail.com
[3]Department of Anaesthesiology, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, India
Email ID: :shkirshada@gmail.com@gmail.com
[4]Department of Anaesthesiology, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, IndiaEmail ID: besina.qayoom@gmail.com
[5]Department of Anaesthesiology, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, India
Email ID: aaqibsuhailmir@gmail.com
[6*]Department of Anaesthesiology, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, India email: mehreenmeer28@gmail.com

***Corresponding Author:** Dr. Mehreen Meer
*Department of Anaesthesiology, Sher-i-Kashmir Institute of Medical Sciences, Srinagar, India email: mehreenmeer28@gmail.com

Abstract:
Background: Spinal anesthesia is widely used for lower abdominal surgeries due to its reliability, cost-effectiveness, and rapid onset. However, the limited duration of local anesthetics such as ropivacaine necessitates the use of adjuvants to prolong block and improve postoperative analgesia. Fentanyl, an opioid, enhances block quality but is associated with opioid-related side effects. Dexmedetomidine, a selective α2-adrenergic agonist, has shown promise as an intrathecal adjuvant with superior block characteristics and fewer complications.
Objective: This prospective observational study compared the efficacy of intrathecal fentanyl versus dexmedetomidine as adjuvants to isobaric ropivacaine in patients undergoing lower abdominal surgeries.
Methods: Eighty ASA I–II patients were randomized into two groups: Group RD (ropivacaine + dexmedetomidine, n=40) and Group RF (ropivacaine + fentanyl, n=40). Demographic variables, block onset, duration, hemodynamic changes, analgesic requirements, and side effects were recorded and analyzed.
Results: Both groups were comparable in baseline characteristics. The onset of sensory (159.2±7.39 vs. 189.7±9.34 sec) and motor block (453.2±10.61 vs. 489.4±9.68 sec) was significantly faster in Group RD. The duration of sensory (191.8±4.81 vs. 135.8±3.22 min) and motor block (152.9±4.99 vs. 126.5±3.05 min) was significantly longer with dexmedetomidine. Time to first analgesic request was also prolonged in Group RD (265±71.4 vs. 203±35.6 min). Hemodynamic parameters were stable in both groups, with mild bradycardia more frequent in Group RD but easily managed. Adverse effects were minimal and comparable.
Conclusion: Intrathecal dexmedetomidine as an adjuvant to isobaric ropivacaine provides faster onset, prolonged sensory and motor block, extended postoperative analgesia, and stable hemodynamics compared to fentanyl. Dexmedetomidine appears to be a superior alternative for lower abdominal surgeries.

Keywords: Anesthesia, Spinal, Ropivacaine, Dexmedetomidine, Fentanyl, Adrenergic alpha-2 Receptor Agonists

Introduction

Spinal anesthesia remains one of the most widely used regional anesthesia techniques for lower abdominal surgeries due to its rapid onset, reliability, and cost-effectiveness. However, the relatively short duration of local anesthetics alone often necessitates early postoperative analgesic intervention. To overcome this limitation, various adjuvants are administered intrathecally with local anesthetics to enhance block characteristics and prolong analgesia. Ropivacaine, a long-acting amide local anesthetic with a favorable safety profile compared to bupivacaine, is increasingly preferred in spinal anesthesia. It offers effective sensory block with reduced cardiotoxicity and neurotoxicity, making it particularly suitable in patients

undergoing lower abdominal procedures. Nevertheless, ropivacaine alone provides limited postoperative analgesia, necessitating the use of adjuvants.Fentanyl, a lipophilic opioid, has long been used as an intrathecal adjuvant. It enhances the quality of sensory block and reduces the dose requirement of local anesthetics. However, opioid-related side effects such as pruritus, nausea, vomiting, urinary retention, and respiratory depression limit its widespread use. Furthermore, concerns regarding opioid tolerance and dependence highlight the need for safer alternatives. Dexmedetomidine, a highly selective α2-adrenergic agonist, has emerged as a promising intrathecal adjuvant. It provides sedative, anxiolytic, and analgesic effects through sympatholytic action, reducing norepinephrine release at the presynaptic level. Several studies have demonstrated that dexmedetomidine prolongs sensory and motor block, improves hemodynamic stability, and extends postoperative analgesia with minimal opioid-like side effects. It also reduces the overall requirement for rescue analgesics, thereby improving patient satisfaction.Although both fentanyl and dexmedetomidine are used intrathecally as adjuvants, limited evidence exists directly comparing their efficacy with isobaric ropivacaine, especially in lower abdominal surgeries. Most studies have been conducted with hyperbaric bupivacaine, leaving a gap in knowledge regarding ropivacaine-based spinal anesthesia. Hence, this study was designed to compare isobaric ropivacaine with fentanyl versus dexmedetomidine for lower abdominal surgeries. [1,19,2,9,20,3,4,6,7]

Aims and Objectives

The aims of this prospective observational study were:

- To compare the efficacy of Dexmedetomidine and Fentanyl when given intrathecally as an adjuvant to 3 ml of 0.5% isobaric Ropivacaine.
- To compare block characteristics between the two groups.
- To compare hemodynamic parameters and side effects, if any, between the two groups.
- To compare postoperative analgesia between the two groups.

Statistics

The recorded data was compiled and entered in Microsoft Excel and analyzed using SPSS Version 20.0. Continuous variables were expressed as Mean ± Standard Deviation (SD) and categorical variables as frequencies and percentages. Student's independent t-test or Mann–Whitney U-test was used for continuous variables. Chi-square test or Fisher's exact test was applied for categorical variables. A P-value <0.05 was considered statistically significant.

Results

A total of 80 patients were enrolled and divided into two equal groups: Group RD (Ropivacaine + Dexmedetomidine) and Group RF (Ropivacaine + Fentanyl). Both groups were comparable with respect to demographic variables (age, gender, ASA status, and weight).

Table 1: Age distribution

Group	N	Age Range (yrs)	Mean ± SD	P-value
RD	40	19-63	40.6 ± 11.79	0.523
RF	40	20-64	42.2 ± 10.85	

Legend: Comparison of mean age between Group RD and Group RF (statistically insignificant).

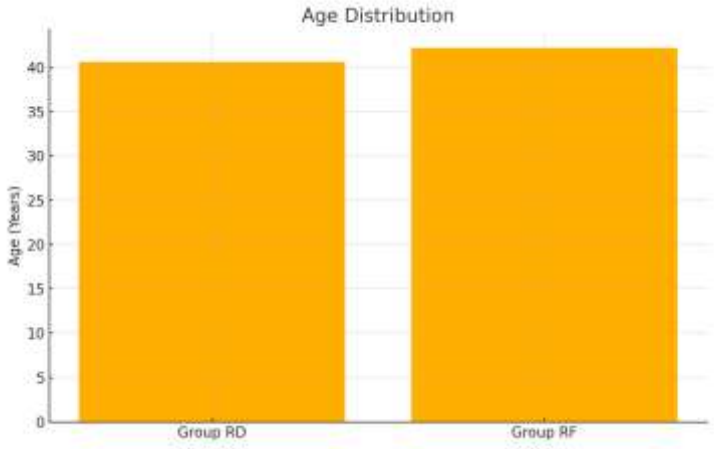

Figure 1: Bar diagram showing mean age distribution in both groups.

Table 2: Gender distribution

Gender	Group RD (N=40)	Group RF (N=40)	P-value
Male	21 (52.5%)	23 (57.5%)	0.653
Female	19 (47.5%)	17 (42.5%)	

Legend: Comparison of gender distribution in both groups (p=0.653, not significant).

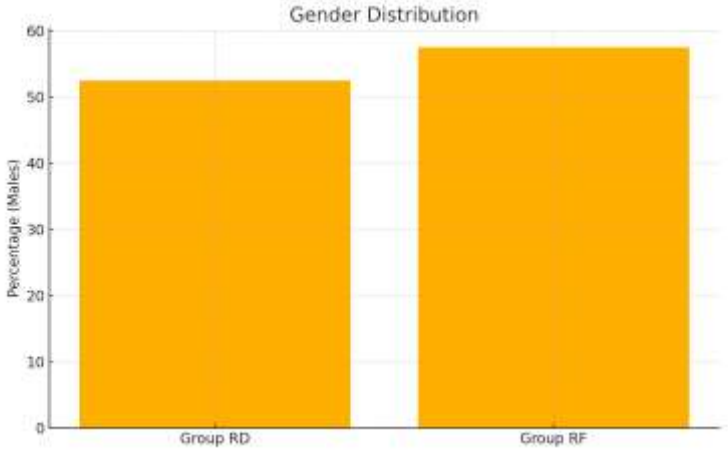

Figure 2: Gender distribution of study patients in both groups.

Table 3: Weight distribution

Group	N	Weight Range (Kg)	Mean ± SD	P-value
RD	40	52-75	64.10 ± 4.76	0.241
RF	40	55-70	62.95 ± 3.87	

Legend: Comparison of mean weight between the two groups (statistically insignificant).

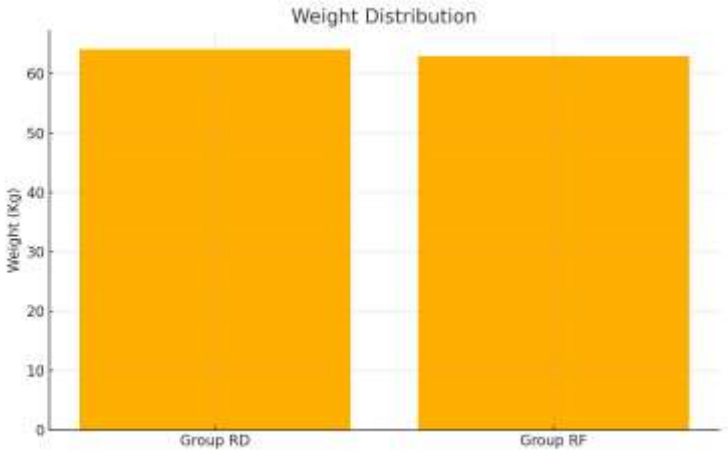

Figure 3: Average weight distribution in Group RD and RF.

Table 4: Preoperative Vitals

Parameter	Group RD Mean ± SD	Group RF Mean ± SD	P-value
HR (beats/min)	84.13 ± 7.14	83.25 ± 7.79	0.602
SBP (mmHg)	124.6 ± 10.5	125.0 ± 11.05	0.992
DBP (mmHg)	77.5 ± 5.92	78.33 ± 6.57	0.557
MAP (mmHg)	93.19 ± 6.89	93.74 ± 7.2	0.726
SpO2 (%)	95.98 ± 1.33	95.7 ± 1.30	0.353
RR (breaths/min)	15.03 ± 1.61	14.85 ± 1.58	0.625

Legend: Baseline preoperative vitals compared between both groups (no significant difference).

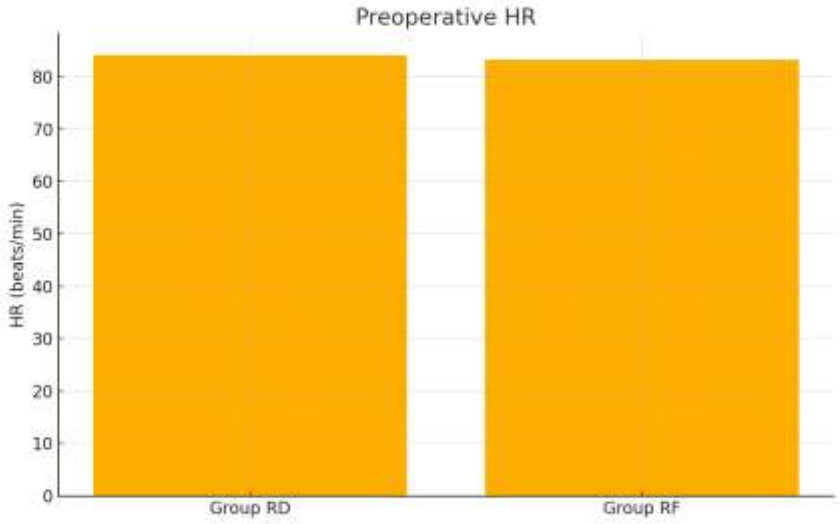

Figure 4: Comparison of baseline HR in Group RD and RF.

Table 5: Level of Sensory Block

Level	Group RD (N=40)	Group RF (N=40)	P-value
T5	5 (12.5%)	4 (10.0%)	0.903
T6	6 (15.0%)	5 (12.5%)	
T7	13 (32.5%)	12 (30.0%)	
T8	9 (22.5%)	13 (32.5%)	
T9	7 (17.5%)	6 (15.0%)	

Legend: Distribution of sensory block levels achieved between Group RD and RF (not significant).

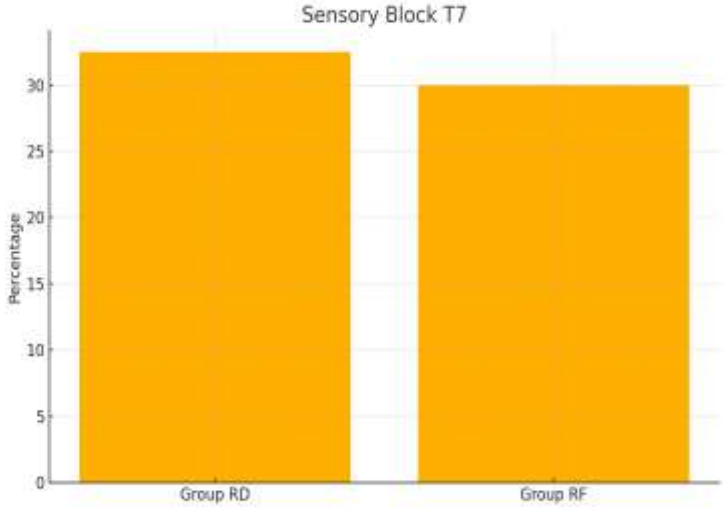

Figure 5: Bar diagram showing sensory block levels achieved (T7 most frequent).

Table 6: Onset of Sensory Block

Group	N	Range (sec)	Mean ± SD	P-value
RD	40	148-171	159.2 ± 7.39	<0.001*
RF	40	175-207	189.7 ± 9.34	

Legend: Mean onset of sensory block in seconds between the two groups (statistically significant, faster in Group RD).

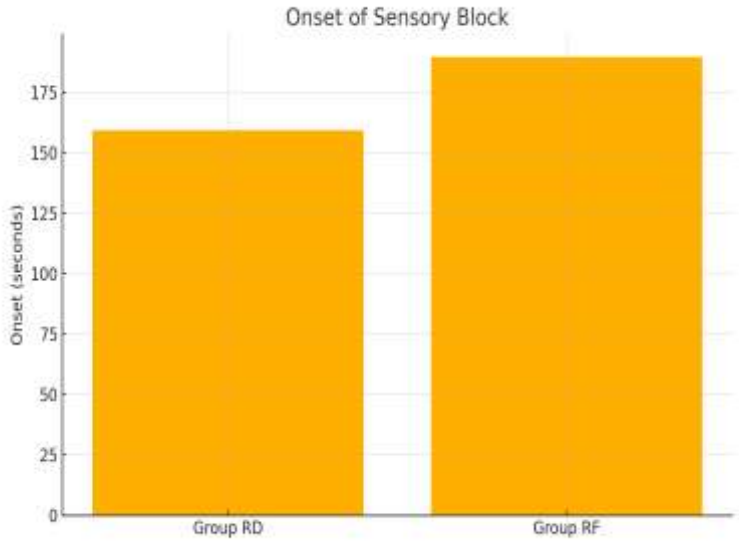

Figure 6: Mean onset of sensory block (faster in Group RD).

Table 7: Duration of Sensory Block

Group	N	Range (min)	Mean ± SD	P-value
RD	40	184-198	191.8 ± 4.81	<0.001*
RF	40	130-142	135.8 ± 3.22	

Legend: Comparison of duration of sensory block (minutes) between the groups (significantly longer in Group RD).

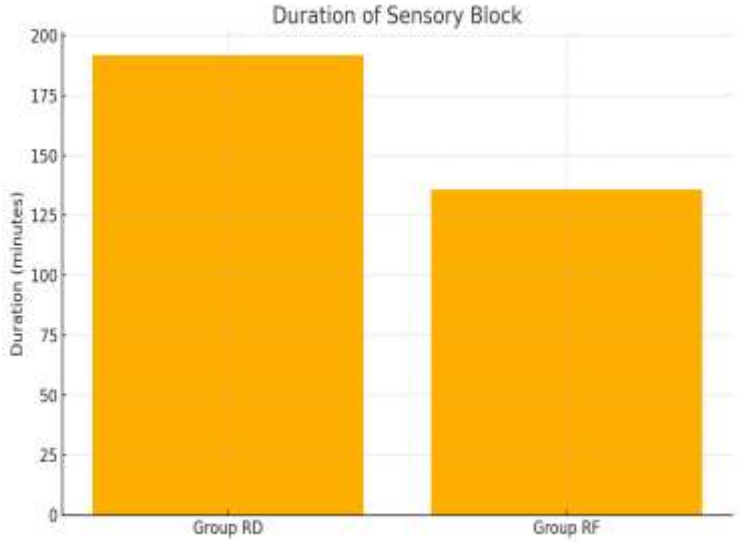

Figure 7: Duration of sensory block significantly longer in Group RD.

Table 8: Level of Motor Block

Motor Block (Bromage Scale)	Group RD (N=40)	Group RF (N=40)	P-value
Grade I	0 (0.0%)	0 (0.0%)	0.176
Grade II	3 (7.5%)	7 (17.5%)	
Grade III	37 (92.5%)	33 (82.5%)	

Legend: Distribution of motor block grades (Bromage scale) in both groups (not statistically significant).

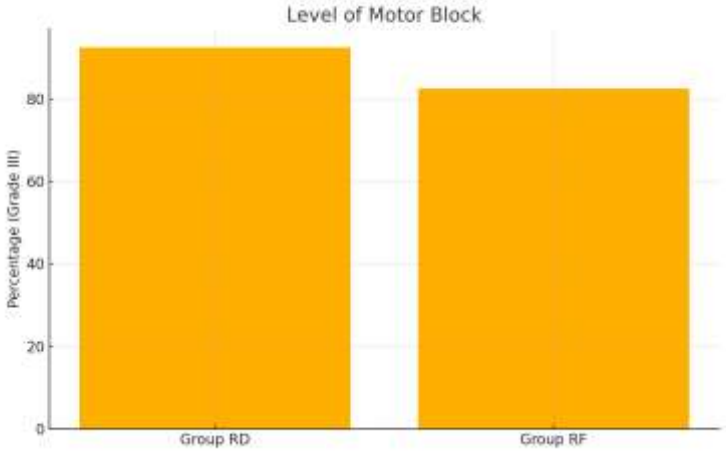

Figure 8: Motor block distribution showing Grade III predominance in both groups.

Table 9: Onset of Motor Block

Group	N	Range (sec)	Mean ± SD	P-value
RD	40	434-487	453.2 ± 10.61	<0.001*
RF	40	472-507	489.4 ± 9.68	

Legend: Comparison of onset of motor block in seconds between groups (significantly faster in Group RD).

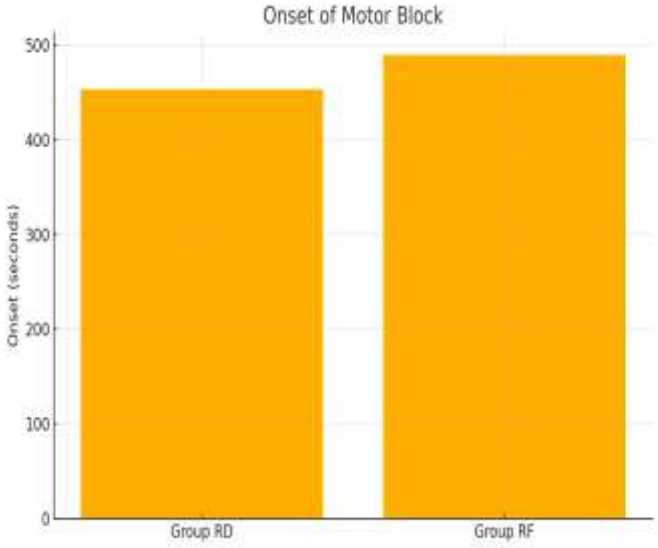

Figure 9: Mean onset of motor block (faster in Group RD).

Table 10: Duration of Motor Block

Group	N	Range (min)	Mean ± SD	P-value
RD	40	143-160	152.9 ± 4.99	<0.001*
RF	40	122-136	126.5 ± 3.05	

Legend: Comparison of duration of motor block (minutes) between groups (significantly longer in Group RD).

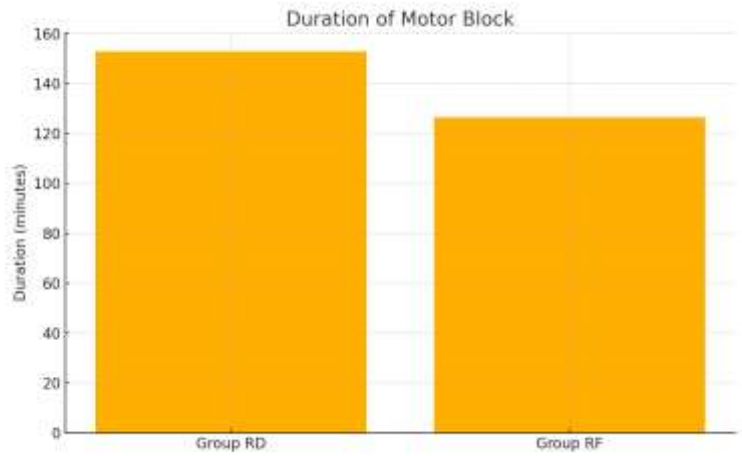

Figure 10: Duration of motor block significantly longer in Group RD.

Table 11: Postoperative Analgesia

Group	N	Mean Time to First Analgesic (min)	P-value
RD	40	265 ± 71.4	<0.001*
RF	40	203 ± 35.6	

Legend: Comparison of time to first analgesic requirement between groups (significantly longer in Group RD).

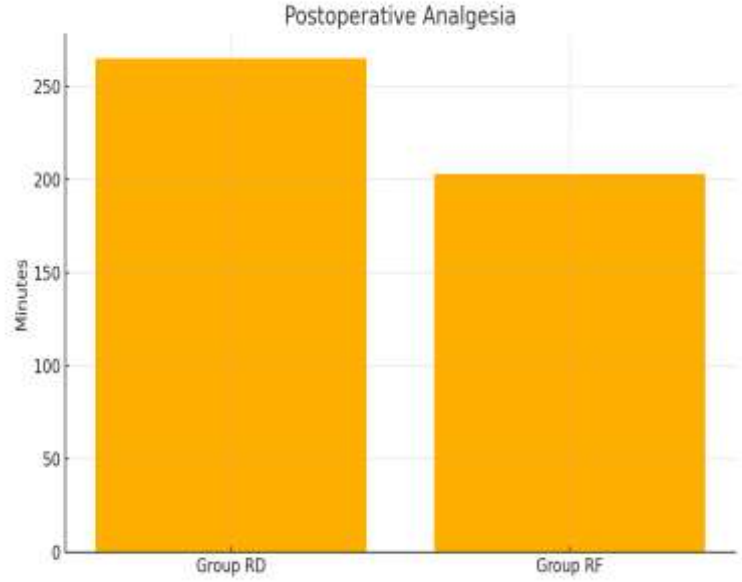

Figure 11: Comparison of mean time to first analgesic requirement between groups.

Table 12: Postoperative Complications

Complication	Group RD (N=40)	Group RF (N=40)	P-value
Hypotension	10%	15%	NS
Bradycardia	5%	8%	NS
Nausea/Vomiting	7%	10%	NS

Legend: Incidence of hypotension, bradycardia, and nausea/vomiting between groups (differences not statistically significant)

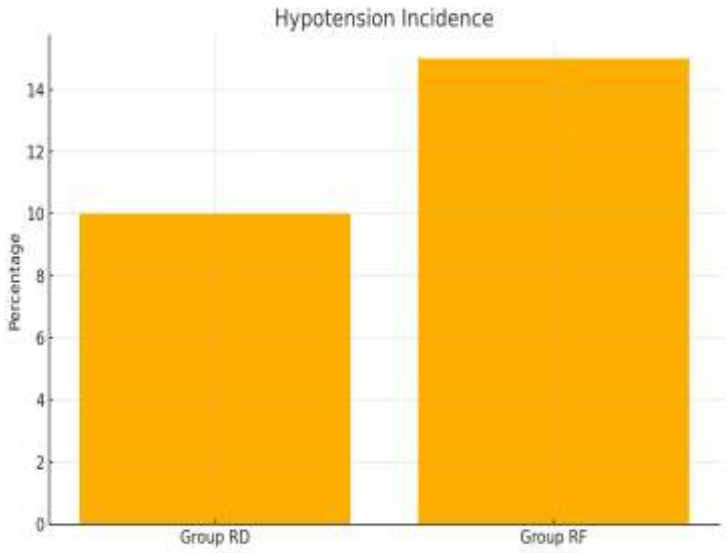

Figure 12: Incidence of hypotension among patients in both groups.

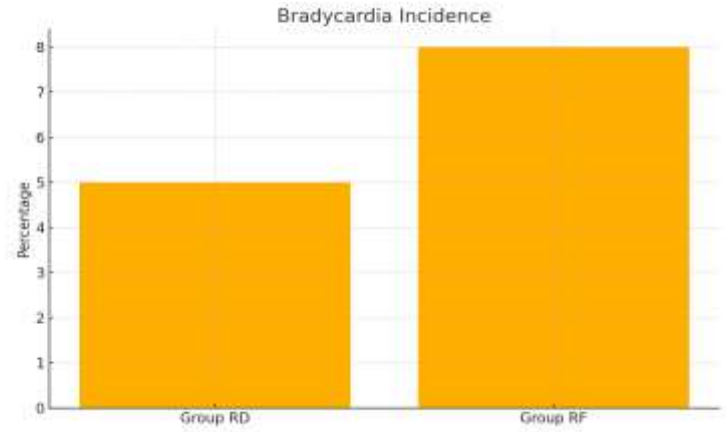

Figure 13: Incidence of bradycardia among patients in both groups.

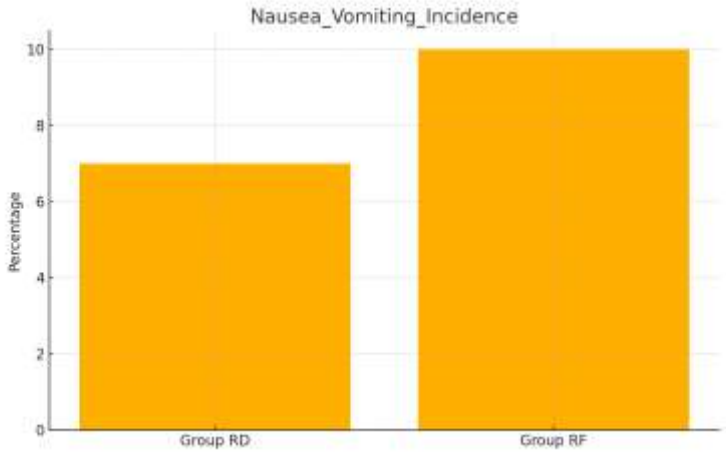

Figure 14: Incidence of nausea/vomiting among patients in both groups.

Summary Table and Combined Graph

Table 13: Summary of Block Characteristics

Parameter	Group RD Mean ± SD	Group RF Mean ± SD	P-value
Onset of Sensory Block (sec)	159.2 ± 7.39	189.7 ± 9.34	<0.001*
Onset of Motor Block (sec)	453.2 ± 10.61	489.4 ± 9.68	<0.001*
Duration of Sensory Block (min)	191.8 ± 4.81	135.8 ± 3.22	<0.001*
Duration of Motor Block (min)	152.9 ± 4.99	126.5 ± 3.05	<0.001*

Legend: Comparison of sensory and motor block onset and duration between Group RD and Group RF (all statistically significant).

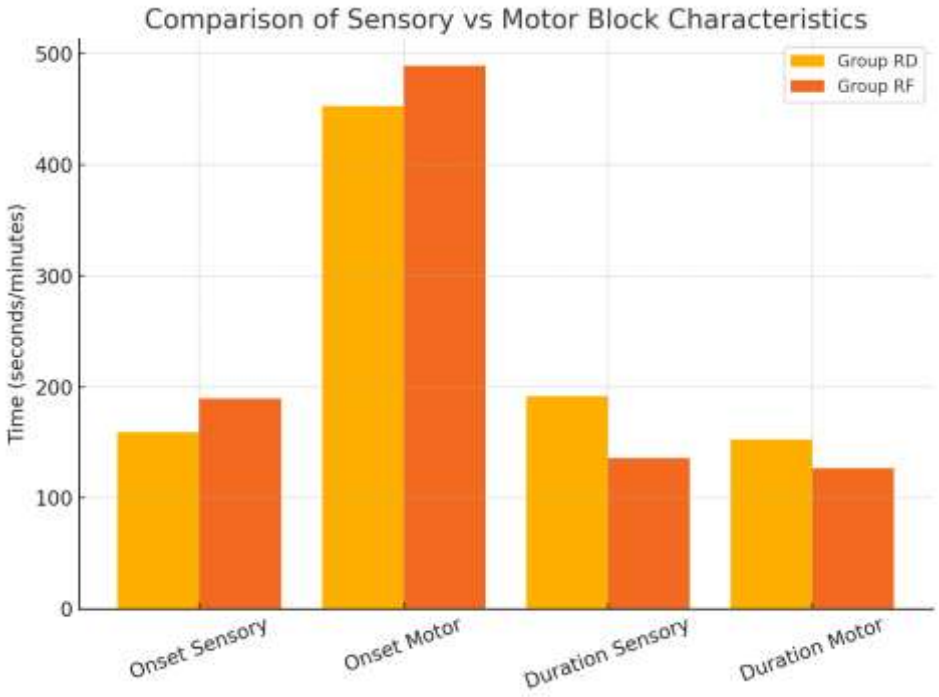

Figure 15: Combined comparative graph showing onset and duration of sensory and motor block between Group RD and RF.

Discussion

The present prospective observational study was conducted to compare the efficacy and safety of dexmedetomidine and fentanyl as intrathecal adjuvants to 0.5% isobaric ropivacaine in patients undergoing lower abdominal surgeries. The study demonstrated that while both agents are effective and safe in providing adequate surgical anesthesia, dexmedetomidine offered distinct advantages over fentanyl with respect to onset and duration of block, quality of postoperative analgesia, and overall hemodynamic stability. [3,8,20,1]

Our findings clearly indicate that the onset of both sensory and motor block was significantly earlier with dexmedetomidine compared to fentanyl. Furthermore, the duration of sensory block (191.8±4.81 min vs. 135.8±3.22 min) and motor block (152.9±4.99 min vs. 126.5±3.05 min) was markedly prolonged in the dexmedetomidine group. This prolonged duration translated into extended postoperative analgesia and delayed requirement for rescue medication, which is of immense clinical benefit in reducing opioid consumption and improving patient satisfaction. These results are in concordance with studies by Gupta et al. (2011) and Singh et al. (2015), who reported that intrathecal dexmedetomidine provided prolonged sensory and motor block as well as superior analgesia when compared to fentanyl or saline controls. [2,5,3,8]

In terms of hemodynamic parameters, both groups remained largely stable intraoperatively. However, mild bradycardia was more frequently noted with dexmedetomidine, although it was easily managed with standard interventions. This observation is consistent with the pharmacological profile of α2-adrenergic agonists and corroborates earlier studies by Mahendru et al. (2013) and Hari Kishore et al. (2015), who noted similar reductions in heart rate without significant adverse outcomes. Importantly, unlike fentanyl, dexmedetomidine does not carry a risk of pruritus or respiratory depression, making it safer in vulnerable populations. [4,20,1]

The superior quality of postoperative analgesia with dexmedetomidine in our study mirrors the results of

Ravipati et al. (2017) and Lhamo Dolma et al. (2018), who reported longer analgesic duration and reduced analgesic requirements when dexmedetomidine was combined with ropivacaine. Similarly, Nayagam et al. (2014) concluded that dexmedetomidine offered better block spread and prolonged analgesia compared to fentanyl when added to bupivacaine. These consistent results across multiple trials strengthen the evidence base supporting dexmedetomidine as a more efficacious intrathecal adjuvant. [7,6,3,8]

Our study also confirmed that fentanyl, although effective in hastening block onset and providing satisfactory anesthesia, is associated with a relatively shorter duration of block and analgesia. This finding parallels those of Gupta R. et al. (2011) and Rahmizadeh et al. (2018), who demonstrated that while fentanyl enhances the quality of spinal anesthesia, its effects wane earlier than dexmedetomidine, necessitating earlier rescue analgesia. The potential for opioid-related side effects such as nausea, vomiting, and pruritus also limits its universal applicability. [2,9,3,8]

From a clinical perspective, the longer duration of sensory and motor blockade achieved with dexmedetomidine is particularly valuable for lower abdominal surgeries of moderate duration. It minimizes intraoperative supplementation, decreases the postoperative analgesic burden, and may even contribute to earlier ambulation and recovery by providing stable pain control. These advantages, coupled with minimal side effects, make dexmedetomidine an attractive alternative to opioids like fentanyl in current anesthesia practice.

Nevertheless, some limitations must be acknowledged. The present study was observational in design, with a relatively small sample size and restriction to ASA I and II patients. The results may not be generalizable to high-risk groups such as geriatric or cardiac patients, in whom the bradycardic and hypotensive effects of dexmedetomidine may be more pronounced. Furthermore, only a single fixed dose of each adjuvant was tested, whereas dose-response studies may provide deeper insights into optimizing efficacy while minimizing side effects.

In conclusion, this study reaffirms the role of dexmedetomidine and fentanyl as useful intrathecal adjuvants to ropivacaine for lower abdominal surgeries. Both drugs ensured adequate anesthesia and safety; however, dexmedetomidine consistently outperformed fentanyl in terms of earlier onset, prolonged sensory and motor block, superior postoperative analgesia, stable hemodynamic profile, and minimal adverse effects. Our findings, in agreement with multiple previous trials, suggest that dexmedetomidine is a superior alternative to fentanyl as an intrathecal adjuvant. Future large-scale randomized controlled studies across diverse surgical populations are warranted to further validate these results and to explore optimal dosing strategies. [3,8,20,1]

Conclusion

Intrathecal dexmedetomidine as an adjuvant to isobaric ropivacaine provides faster onset, prolonged sensory and motor blockade, better hemodynamic stability, and extended postoperative analgesia compared to fentanyl. Both agents are safe, but dexmedetomidine appears to be a superior adjuvant in lower abdominal surgeries. Its use may reduce postoperative opioid requirements and enhance patient satisfaction. Further large-scale studies are recommended to consolidate these findings.

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