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Original Article

COMPARATIVE EVALUATION BETWEEN INTRATHECAL HYPERBARIC ROPIVACAINE 0.75% ALONE VERSUS INTRATHECAL HYPERBARIC ROPIVACAINE 0.75% AND DEXMEDETOMIDINE IN LOWER ABDOMINAL SURGERIES

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ABSTRACT

Objective: Spinal anesthesia is preferred for lower abdominal surgeries due to its benefits like reduced stress response and lower risk of complications. However, the limited duration of local anesthetics has led to the exploration of adjuvants like dexmedetomidine, which is known to enhance and prolong the anesthetic effect without significant respiratory depression.

Methods: This prospective, randomized study involved 60 ASA I-II patients undergoing lower abdominal surgery, divided into three groups: Group A received intrathecal hyperbaric ropivacaine 0.75% with normal saline, Group B with ropivacaine 0.75% and 2.5 mcg dexmedetomidine, and Group C with ropivacaine 0.75% and 5 mcg dexmedetomidine. The study measured onset and duration of sensory and motor block, hemodynamic parameters, and side effects.

Results: Adding dexmedetomidine enhanced the onset and duration of both sensory and motor blocks. Group C, which received 5 mcg dexmedetomidine, showed the fastest onset and longest duration of block, with stable hemodynamics and minimal side effects compared to ropivacaine alone.

Conclusion: The study concludes that intrathecal dexmedetomidine at 5 mcg with ropivacaine 0.75% significantly improves the efficacy of spinal anesthesia for lower abdominal surgeries, suggesting that this combination could be an effective and safe option for enhancing surgical anesthesia.

Keywords: Ropivacaine, Dexmedetomidine, Intrathecal, Lower abdominal surgery, Spinal anesthesia, Anesthetic adjuvant

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INTRODUCTION

Spinal anesthesia has emerged as a preferred technique for lower abdominal surgeries due to its numerous advantages over general anesthesia. These benefits include reduced stress response, lower risk of airway complications, and decreased incidence of thromboembolic events [1]. However, the limited duration of action of local anesthetics has prompted ongoing research into adjuvants that can enhance and prolong the anesthetic effect [2].

In recent years, dexmedetomidine, a highly selective α2-adrenergic agonist, has garnered significant attention as an intrathecal adjuvant. Its unique pharmacological profile allows it to prolong sensory-motor blockade and enhance analgesia without causing significant respiratory depression [3]. This combination of effects makes dexmedetomidine an attractive option for improving the quality and duration of spinal anesthesia. Previous studies have demonstrated its efficacy in extending the duration of spinal anesthesia when combined with various local anesthetics [4, 5]. Ropivacaine, an amide local anesthetic, has gained popularity in clinical practice due to its favorable safety profile. Compared to bupivacaine, ropivacaine exhibits reduced cardiotoxicity while maintaining similar anesthetic properties [6]. This improved safety margin has led to increased interest in exploring ropivacaine's potential in various anesthetic techniques, including its combination with adjuvants like dexmedetomidine in spinal anesthesia [7].

The synergistic effects of combining ropivacaine with dexmedetomidine in spinal anesthesia have shown promising results across various surgical procedures. However, the optimal dosage and specific benefits of this combination for lower abdominal surgeries remain areas of active investigation. By exploring different doses of dexmedetomidine as an adjuvant to ropivacaine, we aim to contribute to the growing body of knowledge in this field and potentially improve patient outcomes in lower abdominal surgeries.[8]

This study aimed to compare the efficacy of intrathecal hyperbaric ropivacaine 0.75% alone versus its combination with two different doses of dexmedetomidine (2.5mcg and 5mcg) for lower abdominal surgeries. The primary objectives were to assess the onset and duration of sensory and motor block, while secondary objectives included the evaluation of hemodynamic stability and side effects. By conducting this comparative evaluation, we sought to provide valuable insights into the optimal use of these anesthetic agents in clinical practice.

MATERIALS AND METHODS

This prospective randomized, double-blind study was conducted at Jaipur National University Institute for Medical Sciences and Research Centre, Jaipur, Rajasthan, after obtaining approval from the Institutional Ethics Committee. Sixty ASA I-II patients aged 20-60 y, scheduled for elective lower abdominal surgeries under spinal anesthesia, were enrolled after providing written informed consent. Exclusion criteria encompassed patient refusal, ASA grade III or higher, bleeding disorders, local sepsis, allergy to local anesthetics, and patients on anticoagulants or antiplatelet agents. Patients were randomly allocated into three groups of 20 each:

Group A: Hyperbaric ropivacaine 0.75% (3 ml)+0.5 ml normal saline

Group B: Hyperbaric ropivacaine 0.75% (3 ml)+dexmedetomidine 2.5mcg in 0.5 ml normal saline

Group C: Hyperbaric ropivacaine 0.75% (3 ml)+dexmedetomidine 5mcg in 0.5 ml normal saline

Pre-anesthetic evaluation included a detailed history, physical examination, and relevant investigations. In the operating room, standard monitors (ECG, NIBP, SpO_2) were attached and baseline vital parameters were recorded. Intravenous access was secured and patients were preloaded with 500 ml of Ringer's lactate solution. Under aseptic precautions, lumbar puncture was

performed at the L3-L4 interspace using a 25G Quincke needle with the patient in sitting position. After confirming free flow of CSF, the study drug was injected intrathecally as per group allocation and patients were immediately placed in supine position.

The study assessed the onset and duration of sensory block (using pinprick method), time to achieve maximum sensory block, two-segment regression time, onset and duration of motor block (using modified Bromage scale), hemodynamic parameters (SBP, DBP, MAP, HR, SpO_2) at regular intervals, and side effects (nausea, vomiting, hypotension, bradycardia).

Statistical analysis

Statistical analysis was performed using SPSS version 23.0. Continuous variables were expressed as mean±SD and analyzed using ANOVA. Categorical variables were expressed as frequencies and percentages and analyzed using the Chi-square test. A p-value ≤0.05 was considered statistically significant.

RESULTS

The demographic profiles were comparable among the three groups as shown in table 1. The data shows that the three groups were comparable in terms of gender distribution, age, weight, height, ASA grade, and duration of surgery. There were no statistically significant differences between the groups for any of these parameters (p>0.05). This comparability is crucial as it minimizes potential confounding factors and allows for a more accurate assessment of the effects of the different anesthetic regimens.

The sensory and motor block characteristics showed significant differences among the groups, as presented in Tables 2 and 3. Table 2 illustrates the sensory block characteristics among the study groups. The results show a clear trend in the onset and duration of sensory block across the groups. Group C (ropivacaine+dexmedetomidine 5mcg) demonstrated the fastest onset of sensory block (8.13±1.52 min), followed by Group B (9.28±1.56 min), and then Group A (11.33±1.44 min). The differences between Group A and the other two groups were statistically significant (p<0.05).

Table 1: Demographic profile among the study groups

Variables	Group A	Group B	Group C	p-value
Gender (M/F)	9/11	7/13	10/10	0.71
Age (y)	38.77±12.87	36.63±13.76	39.12±10.78	0.64
Weight (kg)	59.83±11.38	60.98±9.58	60.23±10.71	0.36
Height (cm)	164.22±11.34	162.41±11.77	160.54±10.73	0.48
ASA Grade (I/II)	8/12	9/11	11/9	0.61
Duration of Surgery (min)	87.48±10.87	84.52±11.69	82.45±10.32	0.47

Similarly, the two-segment regression time was significantly longer in Groups B and C compared to Group A (p<0.01), with Group C showing the longest duration. These findings suggest that the addition of dexmedetomidine, particularly at the higher dose, significantly enhances the speed of onset and prolongs the duration of sensory block.

Table 2: Sensory block characteristics among the study groups

Variables	Group A	Group B	Group C	p-value (A vs B, A vs C, B vs C)
Onset of sensory block (min)	11.33±1.44	9.28±1.56	8.13±1.52	0.006*, 0.002*, 0.07
Time to peak sensory block (min)	20.7±4.32	18.2±4.83	16.91±3.5	0.11, 0.06, 0.23
Two-segment regression time (min)	103.4±16.08	149.51±17.22	165.11	<0.01*, 0.001*, 0.72

Table 3: Time to achieve the motor block among the study groups

Variables	Group A	Group B	Group C	p-value (A vs B, A vs C, B vs C)
Onset of motor block (min)	20.86±2.20	18.98±2.47	13.31±3.32	0.15, 0.001*, 0.029*
Total duration of motor block (min)	249.12±17.01	290.5±18.3	340.8±15.4	0.004*,<0.01*, 0.008*

Table 3 presents the motor block characteristics among the study groups. The data reveals a similar pattern to the sensory block characteristics. Group C showed the fastest onset of motor block (13.31±3.32 min), which was significantly quicker than both Group A and Group B (p<0.05). The total duration of motor block was also significantly longer in Groups B and C compared to Group A (p<0.01), with Group C demonstrating the longest duration (340.8±15.4 min). These results indicate that dexmedetomidine, especially at the 5mcg dose, not only enhances sensory block but also significantly improves the quality and duration of motor block.

Hemodynamic parameters (SBP, DBP, MAP, HR, SpO_2) were comparable among groups at all time intervals, with no clinically significant differences. No major side effects were reported in any group, with only minor incidences of nausea, vomiting, and hypotension observed.

DISCUSSION

This study aimed to evaluate the efficacy of intrathecal hyperbaric ropivacaine 0.75% alone versus its combination with two different doses of dexmedetomidine (2.5mcg and 5mcg) in lower abdominal surgeries. The results demonstrate a significant enhancement in the quality and duration of spinal anesthesia with the addition of dexmedetomidine, particularly at the 5mcg dose.

Our findings reveal a dose-dependent reduction in the onset time of sensory block with the addition of dexmedetomidine. Group C (ropivacaine+dexmedetomidine 5mcg) showed the fastest onset (8.13±1.52 min), followed by Group B (9.28±1.56 min), and then Group A (11.33±1.44 min). This accelerated onset aligns with the results reported by Mahendru *et al.* (2013), who found that intrathecal dexmedetomidine significantly shortened the onset time of sensory block when added to hyperbaric bupivacaine [9]. Similarly, Bi *et al.* (2017) observed a faster onset of sensory block when dexmedetomidine was added to ropivacaine for spinal anesthesia in lower limb surgeries [10].

The mechanism behind this rapid onset can be attributed to the synergistic action of dexmedetomidine with local anesthetics. Zhang *et al.* (2013) elucidated that dexmedetomidine acts on α2A receptors in the spinal cord, enhancing the effects of local anesthetics by inhibiting the release of nociceptive transmitters and hyperpolarizing dorsal horn neurons [11]. This synergistic effect was further corroborated by Li *et al.* (2014), who demonstrated that dexmedetomidine potentiates the analgesic effects of local anesthetics through both central and peripheral mechanisms [12].

Moreover, the duration of sensory block, as indicated by the two-segment regression time, was significantly prolonged in the dexmedetomidine groups. This prolongation was most pronounced

in Group C, suggesting a dose-dependent effect. These findings corroborate the results of Eid *et al.* (2011), who demonstrated a progressive increase in the duration of the sensory block with increasing doses of intrathecal dexmedetomidine (from 5 to 15 mcg) when added to bupivacaine [13]. Sun *et al.* (2015) also reported a dose-dependent prolongation of the sensory block when dexmedetomidine was used as an adjuvant to bupivacaine in spinal anesthesia for cesarean section [14].

The motor block characteristics in our study followed a similar pattern to the sensory block. The onset of motor block was significantly faster in the dexmedetomidine groups, with Group C showing the quickest onset (13.31±3.32 min). The total duration of motor block was also substantially prolonged in Groups B and C compared to Group A, with Group C demonstrating the longest duration (340.8±15.4 min). These findings are consistent with those reported by Kanazi *et al.* (2006), who proposed that the prolongation of motor block by dexmedetomidine could be due to its binding to motor neurons in the dorsal horn [15] Xu *et al.* (2017) further explored this mechanism, suggesting that dexmedetomidine enhances the local anesthetic blockade of motor neurons through a complex interaction with voltage-gated sodium channels [16].

A crucial aspect of our findings is the maintenance of hemodynamic stability across all groups despite the enhanced anesthetic effects in the dexmedetomidine groups. This observation aligns with the results reported by Naithani *et al.* (2015), who found that intrathecal dexmedetomidine in doses up to 5 mcg did not cause significant hemodynamic changes when combined with ropivacaine [17]. The preservation of hemodynamic stability is particularly important in the context of spinal anesthesia, where hypotension is a common concern. Interestingly, Liu *et al.* (2016) suggested that the α2-adrenergic agonist properties of dexmedetomidine might actually contribute to hemodynamic stability by reducing the sympatholytic effects of spinal anesthesia [18].

The absence of significant side effects, particularly at the 5mcg dose of dexmedetomidine, is noteworthy. This favorable safety profile is consistent with the findings of Gupta *et al.* (2011), who reported minimal side effects when using dexmedetomidine as an adjuvant to ropivacaine in epidural anesthesia [19]. However, it's important to note that our study's sample size may not be sufficient to detect rare adverse events. Meta-analyses by Wang *et al.* (2018) and Zhang *et al.* (2017) have provided more comprehensive safety data on intrathecal dexmedetomidine, suggesting a favorable risk-benefit profile when used as an adjuvant in spinal anesthesia [20, 21].

The clinical implications of our findings are substantial. The faster onset and prolonged duration of both sensory and motor blockade with dexmedetomidine can potentially improve surgical conditions and patient comfort. The extended post-operative analgesia may reduce the need for additional pain management interventions, potentially leading to earlier mobilization and improved patient outcomes. This is supported by the work of Dixit *et al.* (2020), who demonstrated that patients receiving intrathecal dexmedetomidine as an adjuvant to ropivacaine had lower postoperative pain scores and reduced analgesic requirements compared to those receiving ropivacaine alone [22]. Furthermore, a systematic review by Jin *et al.* (2021) concluded that intrathecal dexmedetomidine significantly improves postoperative analgesia and reduces opioid consumption across various surgical procedures [23].

While our study focused on dexmedetomidine, it's worth considering how these results compare to other commonly used adjuvants. A meta-analysis by Gao *et al.* (2022) compared dexmedetomidine with fentanyl as adjuvants in spinal anesthesia for cesarean section [24]. They found that dexmedetomidine provided longer-lasting analgesia and motor block compared to fentanyl, with a similar safety profile. Similarly, Miao *et al.* (2018) conducted a network meta-analysis comparing various intrathecal adjuvants and found dexmedetomidine to be among the most effective in prolonging analgesia and reducing postoperative pain [25].

Despite the promising results, our study has several limitations. The single-center design and relatively small sample size may limit the generalizability of our findings. Future multicenter studies with larger sample sizes could provide more comprehensive data on the efficacy and safety of this anesthetic combination across varied clinical settings and diverse patient populations. Additionally, while we focused on lower abdominal surgeries, the optimal dose of intrathecal dexmedetomidine may vary depending on the specific surgical procedure and patient characteristics. Further research is needed to establish optimal dosing guidelines for different types of surgeries and patient groups, including pediatric and geriatric populations.

CONCLUSION

Intrathecal dexmedetomidine, especially at a dose of 5mcg, significantly improves the onset and duration of sensory and motor blockade when combined with hyperbaric ropivacaine 0.75% for lower abdominal surgeries. This combination provides stable hemodynamics and minimal side effects, making it an effective option for these procedures. The enhanced quality and duration of anesthesia may lead to improved patient comfort and potentially reduce the need for postoperative analgesics.

However, further large-scale studies are warranted to explore the optimal dosage, long-term outcomes, and potential applications in different surgical settings. Additionally, future research could investigate the combination of dexmedetomidine with other local anesthetics and its effects in various patient populations.

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AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

Declared none

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