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A COMPARATIVE STUDY OF DEXMEDETOMIDINE AND CLONIDINE AS AN ADJUVANT TO INTRATHECAL BUPIVACAINE IN LOWER ABDOMINAL SURGERIES

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Abstract:
Background: α2-adrenergic agonists such as dexmedetomidine and clonidine are widely used intrathecal adjuvants to prolong the quality and duration of spinal anaesthesia. This study compared their efficacy and safety in patients undergoing lower abdominal surgeries.
Methods: Sixty ASA I–II patients scheduled for elective lower abdominal surgeries under spinal anaesthesia were randomly divided into two groups: Group D (n=30) received intrathecal dexmedetomidine (5 µg) with 0.5% bupivacaine, while Group C (n=30) received clonidine (30 µg) with 0.5% bupivacaine. Onset and duration of sensory and motor block, duration of effective analgesia, hemodynamic changes, and side effects were recorded.
Results: Demographic parameters and surgical duration were comparable between groups ($p>0.05$). The onset of sensory block was significantly faster in Group D (2.6 ± 0.8 min) than in Group C (3.8 ± 1.0 min, $p<0.001$). Duration of sensory block (245.6 ± 28.3 vs. 198.7 ± 25.4 min, $p<0.001$) and motor block (210.4 ± 26.7 vs. 172.5 ± 23.8 min, $p<0.001$) were both significantly longer in Group D. Effective postoperative analgesia was also prolonged with dexmedetomidine (310.5 ± 35.8 vs. 248.6 ± 32.7 min, $p<0.001$). Hemodynamic profiles were stable in both groups; Group D showed slightly lower MAP values at 10–20 min, though not statistically significant. Side effects were mild and comparable, with hypotension (10% vs. 13.3%), bradycardia (6.6% vs. 3.3%), and nausea/vomiting (6.6% vs. 10%). Mild sedation occurred more frequently with dexmedetomidine (16.6% vs. 6.6%). No respiratory depression was observed.
Conclusion: Intrathecal dexmedetomidine provides faster onset, longer sensory and motor blockade, and significantly prolonged postoperative analgesia compared to clonidine, with stable hemodynamic parameters and minimal side effects. Dexmedetomidine may thus be considered a superior intrathecal adjuvant for lower abdominal surgeries.

Keywords: Dexmedetomidine, Clonidine, Intrathecal bupivacaine, Spinal anaesthesia, Lower abdominal surgery, Analgesia.

INTRODUCTION

Spinal anaesthesia is one of the most widely employed regional anaesthetic techniques for lower abdominal, perineal, and lower limb surgeries. It provides rapid onset, reliable sensory and motor block, superior postoperative analgesia, and avoids complications associated with general anaesthesia such as airway manipulation, nausea, vomiting, and delayed recovery [1,2]. Despite these advantages, the main limitation of spinal anaesthesia with local anaesthetics alone, such as hyperbaric bupivacaine, is its relatively short duration of action. This may not be sufficient for prolonged surgeries or for achieving extended postoperative analgesia [3].

To overcome these limitations, various adjuvants have been added to intrathecal local anaesthetics. These include opioids (morphine, fentanyl), ketamine, neostigmine, magnesium sulphate, and α-2 adrenergic agonists [4]. Among these, α-2 adrenergic agonists have gained popularity due to their ability to enhance neuraxial anaesthesia by producing sedation, analgesia, and sympatholysis without significant respiratory depression [5].

Clonidine, a partial α-2 adrenergic receptor agonist, has been studied extensively as an intrathecal adjuvant. It prolongs sensory and motor block, improves postoperative analgesia, and reduces opioid consumption [6,7]. However, its use may be limited by dose-dependent adverse effects such as bradycardia, hypotension, and sedation [8].

Dexmedetomidine, a newer and highly selective α-2 adrenergic agonist, is approximately eight times more selective for α-2 receptors compared to clonidine [9]. It produces reliable analgesia and sedation while maintaining hemodynamic stability and causing minimal respiratory depression [10]. Several studies have demonstrated that dexmedetomidine, when added to intrathecal bupivacaine, results in a faster onset, prolonged sensory and motor block, and superior postoperative pain relief compared to clonidine [11–13].

Lower abdominal surgeries, such as hernia repair, gynecological procedures, appendectomy, and urological operations, are routinely performed under spinal anaesthesia. In these procedures, prolonging the duration of block and postoperative analgesia without increasing complications is of significant clinical relevance. An ideal intrathecal adjuvant should therefore provide early onset, prolonged duration of action, extended postoperative pain relief, and minimal side effects [14].

Although both clonidine and dexmedetomidine have been widely investigated as intrathecal adjuvants, comparative clinical data remain variable across different populations. Hence, this study was undertaken to compare dexmedetomidine and clonidine as adjuvants to intrathecal bupivacaine in lower abdominal surgeries, focusing on block characteristics, analgesic duration, hemodynamic stability, and side effect profile.

This study was conducted to compare the efficacy of dexmedetomidine and clonidine as adjuvants to intrathecal bupivacaine in patients undergoing lower abdominal surgeries.

MATERIALS AND METHODS:

Study Design and Ethical Approval

This was a prospective, randomized, double-blind, controlled clinical study conducted in the Department of Anaesthesiology **at Viswabharathi Medical College, Kurnool** over a period of **6 months.** The study protocol was reviewed and approved by the Institutional Ethics Committee**.** Written informed consent was obtained from all participants after explaining the procedure, potential risks, and benefits in their own language.

Study Population

A total of 60 adult patients belonging to the American Society of Anesthesiologists (ASA) physical status I and II, aged between 18 and 60 years, scheduled to undergo elective lower abdominal surgeries under spinal anaesthesia, were included in the study.

Inclusion Criteria: Patients of either gender, age 18–60 years, ASA physical status I or II, Patients posted for elective lower abdominal surgeries (e.g., hernia repair, hysterectomy, appendicectomy, gynecological procedures), Patients who provided written informed consent.

Exclusion Criteria: Patient refusal to participate, Known hypersensitivity to study drugs, Contraindications to spinal anaesthesia (bleeding diathesis, infection at puncture site, severe spinal deformity), Patients with significant cardiac, hepatic, renal, or neurological disease, Pregnant or lactating women, Patients on α2-adrenergic agonists, β-blockers, or sedatives.

Randomization and Blinding

Participants were randomly allocated into two equal groups (n=30 each) using a computer-generated randomization table. Allocation concealment was ensured with sealed opaque envelopes. Both the patient and the anaesthesiologist responsible for intraoperative management and data collection were blinded to the group assignment.

- Group D (Dexmedetomidine group): 3 mL of 0.5% hyperbaric bupivacaine + 5 µg dexmedetomidine diluted to a total volume of 3.5 mL.
- Group C (Clonidine group): 3 mL of 0.5% hyperbaric bupivacaine + 30 µg clonidine diluted to a total volume of 3.5 mL.

The study drug solutions were prepared by an independent anaesthesiologist not involved in patient management or data recording.

Anaesthesia Technique:

All patients underwent pre-anaesthetic evaluation a day prior to surgery. Patients were kept nil per oral for at least 6 hours before surgery and premedicated with oral ranitidine 150 mg and alprazolam 0.5 mg on the night before surgery.

In the operating room, standard monitors (ECG, non-invasive blood pressure, pulse oximeter) were applied, and baseline parameters were recorded. Intravenous access was secured, and patients were preloaded with Ringer's lactate solution 10 mL/kg over 15 minutes.

Under strict aseptic precautions, lumbar puncture was performed at the L3–L4 or L4–L5 interspace with a 25G Quincke spinal needle in the sitting position. After confirmation of free cerebrospinal fluid flow, the study drug solution was injected intrathecally over 10–15 seconds without barbotage. Patients were then immediately placed supine. Oxygen at 2 L/min via nasal cannula was administered.

Parameters Observed

- Block characteristics:
  - Onset of sensory block (time to reach T10 level).
  - Maximum sensory level achieved.
  - Duration of sensory block (time from injection to regression to S1 dermatome).
  - Onset of motor block (assessed by Modified Bromage scale).
  - Duration of motor block (time to return to Bromage 0).
- Duration of effective analgesia: Time from intrathecal injection to the first request for rescue analgesic (VAS ≥ 4).
- Hemodynamic parameters: Heart rate (HR), mean arterial pressure (MAP), and oxygen saturation (SpO_2) recorded at baseline, every 5 min for first 20 min, every 15 min intraoperatively, and every 30 min postoperatively for 2 hours, then hourly up to 6 hours.
- Side effects and complications: Hypotension (MAP < 20% of baseline), bradycardia (HR < 50 bpm), nausea, vomiting, sedation, pruritus, respiratory depression (RR < 10/min, SpO_2 < 90%).

Rescue Analgesia and Management of Side Effects

- Hypotension was treated with IV fluids and incremental doses of mephentermine 6 mg IV.
- Bradycardia was treated with atropine 0.6 mg IV.
- Rescue analgesia was provided with IV diclofenac 75 mg when VAS ≥ 4.
- Nausea and vomiting were treated with ondansetron 4 mg IV.

Statistical Analysis: Data were analyzed using SPSS version 20. Continuous variables were expressed as mean ± standard deviation (SD) and compared using Student's *t*-test. Categorical variables were expressed as percentage and analyzed using Chi-square. A p-value < 0.05 was considered statistically significant.

RESULTS;

Patient Characteristics:

A total of 60 patients were enrolled, randomized equally into two groups: Group D (Dexmedetomidine, n=30) and Group C (Clonidine, n=30). Both groups were comparable with respect to age, gender, weight, ASA physical status, and duration of surgery. No statistically significant differences were noted between the two groups ($p > 0.05$) as shown in Table 1

Table 1. Demographic Data

Parameter	Group D (n=30)	Group C (n=30)	p-value
Age (years, mean ± SD)	42.3 ± 8.6	41.7 ± 9.2	0.78
Gender (M/F)	18/12	17/13	0.79
Weight (kg, mean ± SD)	62.8 ± 7.4	63.5 ± 6.9	0.67
ASA I/II	20/10	21/9	0.78
Duration of surgery (min)	95.2 ± 12.6	93.8 ± 13.1	0.62

Dexmedetomidine group showed faster onset and longer duration of both sensory and motor block compared to clonidine as shown in Table 2

Table 2. Characteristics of Sensory and Motor Block

Parameter	Group D (n=30)	Group C (n=30)	p-value
Onset of sensory block (T10, min)	2.6 ± 0.8	3.8 ± 1.0	<0.001*
Maximum sensory level achieved	T6 (T4–T8)	T7 (T5–T8)	0.08
Duration of sensory block (min)	245.6 ± 28.3	198.7 ± 25.4	<0.001*
Onset of motor block (min)	4.1 ± 0.9	5.2 ± 1.1	<0.01*
Duration of motor block (min)	210.4 ± 26.7	172.5 ± 23.8	<0.001*

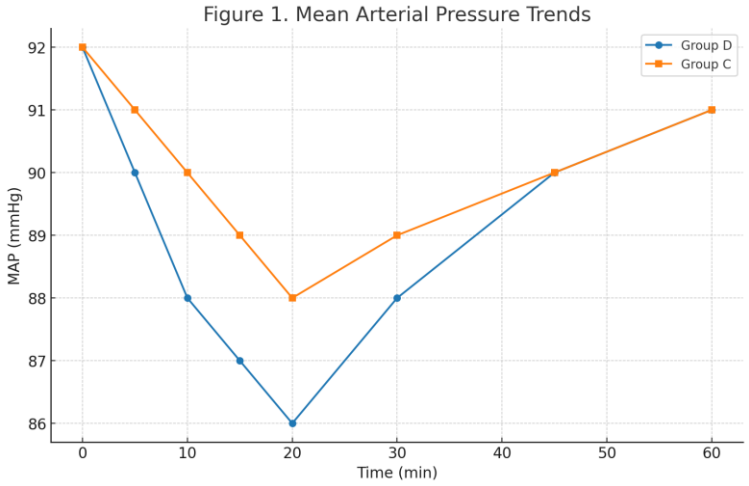
Dexmedetomidine significantly prolonged postoperative analgesia compared to clonidine as shown in Table 3

Table 3. Duration of Analgesia

Parameter	Group D (n=30)	Group C (n=30)	p-value
Duration of effective analgesia (min)	**310.5 ± 35.8**	**248.6 ± 32.7**	**<0.001***

Both groups showed a mild decrease in MAP after spinal injection. Group D had slightly lower MAP values at 10–20 min, but differences were not statistically significant ($p > 0.05$) as shown in fig.1.

Figure 1. Mean Arterial Pressure Trends



Group D demonstrated more stable HR compared to Group C, though occasional bradycardia occurred as shown in fig.2.

Figure 2: Heart rate Trends

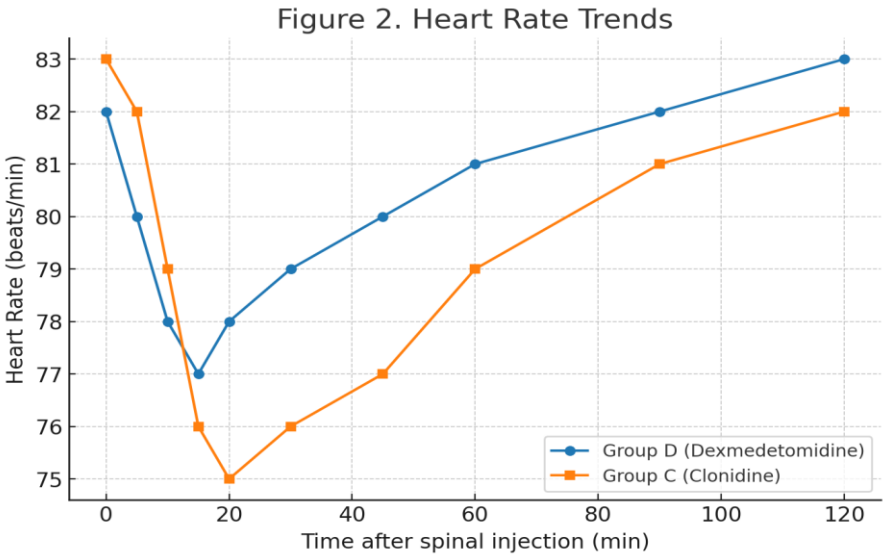


Figure 2. Heart Rate Trends

Both drugs were well tolerated. Mild sedation was more frequent with dexmedetomidine, but no major complications occurred as shown in Table 4

Table 4. Adverse Effects Observed

Side Effect	Group D (n=30)	Group C (n=30)	p-value
Hypotension	3 (10%)	4 (13.3%)	0.69
Bradycardia	2 (6.6%)	1 (3.3%)	0.55
Nausea/Vomiting	2 (6.6%)	3 (10%)	0.64
Sedation (Grade 2)	5 (16.6%)	2 (6.6%)	0.21
Respiratory Depression	0	0	–

DISCUSSION:

In the present study, we compared the effects of dexmedetomidine and clonidine as adjuvants to intrathecal bupivacaine in patients undergoing lower abdominal surgeries. The primary outcomes were sensory and motor block characteristics, duration of postoperative analgesia, hemodynamic profile, and side effects. Our findings demonstrated that both dexmedetomidine and clonidine significantly enhanced the quality of spinal anaesthesia when compared with bupivacaine alone, but dexmedetomidine provided superior block prolongation, prolonged postoperative analgesia, and stable hemodynamics with minimal side effects.

Block Characteristics:

We observed that the onset of sensory block was faster and the duration of both sensory and motor block was significantly longer in the dexmedetomidine group compared with the clonidine group. These results are consistent with the findings of Gupta et al. who reported that intrathecal dexmedetomidine prolonged the duration of block more effectively than clonidine [15].

Similarly, Kanazi et al. (2006) demonstrated that low-dose dexmedetomidine (3 μg) resulted in earlier onset and prolonged sensory block compared to clonidine (30 μg) when added to bupivacaine [16]. The higher selectivity of dexmedetomidine for α-2 adrenergic receptors (α2:α1 ratio of 1620:1) compared to clonidine (α2:α1 ratio of 220:1) may explain its superior efficacy [17].

Postoperative Analgesia:

Postoperative pain relief is one of the key objectives of intrathecal adjuvant use. In our study, patients in the dexmedetomidine group experienced significantly prolonged analgesia compared to the clonidine group. These findings align with Al-Mustafa et al. found that dexmedetomidine as an adjuvant to bupivacaine significantly extended the duration of analgesia in urological surgeries [18]. Likewise, Shukla et al. reported that dexmedetomidine provided longer postoperative analgesia compared with clonidine [19].

The superior analgesic profile of dexmedetomidine may be attributed to its action on the substantia gelatinosa of the spinal cord, where it inhibits C-fiber transmission, reduces release of nociceptive neurotransmitters (substance P), and hyperpolarizes interneurons, leading to enhanced analgesia [20].

Hemodynamic Stability:

Hemodynamic changes such as hypotension and bradycardia are common with α-2 agonists due to sympatholytic. In our study, both groups showed mild decreases in heart rate and mean arterial pressure, but these were more pronounced in the clonidine group compared to dexmedetomidine. This observation is supported by Eisenach et al. noted that clonidine is associated with higher incidences of hypotension and bradycardia compared to dexmedetomidine [21]. Similarly, Maroof et al. demonstrated that dexmedetomidine

provided better hemodynamic stability during spinal anaesthesia [22].

Side Effect Profile:

In our study, hypotension occurred in 10% of patients in the dexmedetomidine group and 13.3% in the clonidine group, while bradycardia was noted in 6.6% and 3.3%, respectively. Maroof et al. [22] demonstrated that dexmedetomidine provides better cardiovascular stability compared to clonidine during spinal anaesthesia.

Sedation (Grade 2) was observed more frequently in the dexmedetomidine group (16.6%) than in the clonidine group (6.6%), although the difference was not statistically significant. This is in agreement with Sudheesh and Harsoor [23], who highlighted dexmedetomidine's sedative properties due to its central action on the locus coeruleus, producing cooperative sedation without respiratory depression. The incidence of nausea and vomiting was low in both groups (6.6% in Group D vs. 10% in Group C), with no statistically significant difference. These results are in line with Shukla et al. [13], who also reported a low incidence of nausea and vomiting with α-2 agonists compared to opioids. Notably, no respiratory depression was observed in either group. Al-Mustafa et al. [18] also reported the absence of respiratory depression with intrathecal dexmedetomidine, reinforcing its safety profile.

CONCLUSION: In conclusion, intrathecal dexmedetomidine is superior to clonidine as an adjuvant to bupivacaine in lower abdominal surgeries. It offers a faster onset, prolonged sensory and motor block, extended postoperative analgesia, and a favorable safety profile. These results support the clinical utility of dexmedetomidine in enhancing the quality of spinal anaesthesia.

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