Section: Anaesthesiology

Original Research Article

EVALUATION OF BUPIVACAINE-CLONIDINE VERSUS BUPIVACAINE-DEXMEDETOMIDINE INTRATHECALLY IN LOWER ABDOMINAL SURGERY: A PROSPECTIVE STUDY

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ABSTRACT

Background: Intrathecal adjuvants like clonidine and dexmedetomidine are used to increase the quality and duration of spinal anesthesia. This particular study intended to compare their efficacy and safety when given in mixture with hyperbaric bupivacaine during lower abdominal surgeries.

Materials and Methods: In this prospective randomized double-blinded study, 56 adult patients (ASA I/II) listed for an elective lower abdominal surgery were enrolled. The 56 patients were randomly assigned to two equal groups: Group BC (bupivacaine + clonidine 30 µg) and Group BD (bupivacaine + dexmedetomidine 5 µg). All patients were given standardized spinal anesthesia. Primary outcomes were onset and duration of sensory and motor block and time to the first rescue analgesia. Secondary outcomes were level of sedation, hemodynamic parameters, and adverse events.

Results: The onset of sensory and motor block was significantly faster in Group BD (3.2 ± 0.9 min and 4.5 ± 1.1 min, respectively) compared with Group BC (4.6 ± 1.1 min and 6.1 ± 1.4 min, $p<0.001$). Furthermore, Group BD also demonstrated statistically longer periods of sensory and motor blockade (223 ± 24 min and 188 ± 21 min) against Group BC (173 ± 22 min and 138 ± 18 min, $p<0.001$). Time to rescue analgesics was delayed in Group BD (255 ± 27 min) versus Group BC (206 ± 25 min, $p<0.001$). Sedation scores were comparably higher with Group BD where the safety profile was acceptable. The incidence of hypotension and bradycardia was notably higher in Group BD (21.4% and 14.3%, respectively), but could be well managed.

Conclusion: In sum, intrathecal dexmedetomidine is preferred over clonidine as an adjunct to bupivacaine for producing a faster onset, prolonged block duration, and prolonged analgesia; thus, from the perspective of enhancing spinal anesthesia for lower abdominal surgeries, it becomes the better choice.

Keywords: Intrathecal anesthesia, dexmedetomidine, clonidine, bupivacaine, spinal block, lower abdominal surgery, postoperative analgesia, adjuvants, sedation, hemodynamic stability.

INTRODUCTION

Spinal anesthesia is one of the most widely applied techniques for lower limb and lower abdominal surgeries because it has a fast onset, is reliable, and is easy to perform. Bupivacaine is mostly used in spinal anesthesia; it is basically a long-acting amid local anesthetic. Its major drawback considered is the limited duration of postoperative analgesia, necessitating the employment of intrathecal adjuvants to prolong analgesic effect, thereby improving the overall quality of anesthesia.[1]

As an intrathecal adjuvant, dexmedetomidine-a highly selective α2-adrenergic receptor agonist-has attracted much attention for its sedative, anxiolytic, analgesic, and sympatholytic properties. When

intrathecal dexmedetomidine is given with bupivacaine, the onset of sensory and motor blockade is faster, and the duration is longer.[2] Bupivacaine plus dexmedetomidine improves intraoperative analgesia and prolongs postoperative analgesic effect, particularly in urological surgeries.[3]

By contrast, another α2-adrenergic agonist, clonidine has been evaluated for its ability to prolong spinal anesthesia. It is said to exert a synergistic effect with local anesthetics in enhancing both sensory and motor block but is less selective for α2 receptors than dexmedetomidine, a factor that may influence both the quality and duration of such an effect.[4]

Magnesium sulfate has also been put forth as an intrathecal adjuvant candidate, particularly with its NMDA receptor antagonistic properties. It certainly has some potential in prolonging analgesia; however, studies confirm that dexmedetomidine still surpasses the adjuvant in performance when it comes to block characteristics and duration.[5] A head-to-head comparison of dexmedetomidine and clonidine as adjuvants to bupivacaine concluded dexmedetomidine gave the block a quicker onset, longer duration, and better postoperative analgesia in patients undergoing lower abdominal surgery.[6]

New recent literature has recorded the increasing use of dexmedetomidine in various anesthetic techniques, not only because of its analgesic properties but also because it decreases the amount of opioids used, thus limiting side effects such as nausea and respiratory depression.[7] In a randomized double-blind trial, dexmedetomidine sequentially administered with bupivacaine maintained stable hemodynamics and provided longer analgesia than fentanyl.[8]

This is further confirmed in the case of high-risk patients such as cancer surgery patients where the use of dexmedetomidine resulted in extended pain relief without the potential hazards of opioid usage.[9] The use of dexmedetomidine combined with bupivacaine was also found to be superior in block onset, duration, and stability as compared to fentanyl.[10]

This study was undertaken to evaluate the efficacy and safety profiles of intrathecal bupivacaine with clonidine and bupivacaine with dexmedetomidine in patients undergoing lower abdominal surgeries. Additionally, the study documented the incidence of adverse effects such as hypotension, bradycardia, nausea, vomiting, and respiratory depression in both the groups.

MATERIALS AND METHODS

This was a prospective, randomized, comparative study conducted in the department of Anesthesiology of a tertiary care teaching hospital to evaluate the efficacy and safety of intrathecal bupivacaine combined with clonidine versus dexmedetomidine in patients undergoing lower abdominal surgeries. Based on previous studies comparing the duration of sensory block, a mean difference of 20 minutes with a standard deviation of 25, 95% confidence level, and 80% power, the minimum required sample size was calculated to be 25 per group. Considering a 10% attrition rate, the final sample size was set at 28 patients per group, totalling 56 participants.

Group BC: received 0.5% hyperbaric bupivacaine with clonidine 30 µg.

Group BD: received 0.5% hyperbaric bupivacaine with dexmedetomidine 5 µg.

Concealment of allocation was ensured using sealed opaque envelopes. The anesthesiologist administering the block was aware of the group, but the observer collecting intraoperative and postoperative data was blinded to group assignment.

Drug Preparation and Administration: Spinal Blocks were given in the L3-L4 or L4-L5 intervertebral spaces using a 25G Quincke spinal needle under strict aseptic techniques. All spinal anesthesia were given with full aseptic techniques. Patients received the following drugs depending upon the group they belonged to

- Group BC received 3 mL of 0.5% hyperbaric bupivacaine with 30 µg clonidine which was diluted to 0.5 mL with preservative free saline."
- Group BD received the same volume of bupivacaine but mixed with 5ug dexmedetomidine instead. Both groups had a total intrathecal volume of 3.5ml.

Monitoring and Data Collection: Heart rate, blood pressure, respiratory rate, and oxygen saturation were recorded prior to spinal injection for baseline values. Following administration, patients were monitored for:

- Sensory block onset and duration,
- Motor block characteristics (Modified Bromage scale),
- Hemodynamic parameters every five minutes
- Sedation score (using Ramsay sedation scale)
- Duration of postoperative analgesia (time to first request for rescue analgesic)
- Adverse effects such as bradycardia, hypotension, nausea, vomiting, and respiratory depression

All data was recorded in a predesigned case record form for subsequent analysis. For statistical purpose p value less than 0.05 was taken as statistically significant.

Inclusion Criteria:

- Patients between ages 18–60.
- ASA physical status I or II.
- Scheduled for elective lower segmental abdominal surgery under spinal anaesthesia.
- Provided written informed consent.

Exclusion Criteria:

- Known allergy to any of the drugs being studied.
- Contraindications to spinal anesthesia (coagulation disorders, local infection).
- History of bradyarrhythmia or other significant heart disease.
- Female patients who are pregnant or breastfeeding.
- Patients taking preoperative α2 agonists or sedatives.

RESULTS

In lower abdominal surgeries, dexmedetomidine provided better adjunct action when given intrathecally compared to clonidine with bupivacaine. Patients in the dexmedetomidine group experienced faster times for the onset of sensory block (3.2 minutes) than those in the clonidine group (4.6 minutes). Also, patients receiving dexmedetomidine had quicker onset times for motor block as well; it was given at 4.5 minutes while clonidine recipients were given it at 6.1 minutes. The two groups differed significantly ($p < 0.001$), which suggests that spinal anesthesia was easier and faster with dexmedetomidine.

Patients in Group BD experienced both types of blocks, sensory and motor, faster and longer than group BC where clonidine was used as an anesthetic. Group BD sustained sensory block for an average of 223 minutes while group BC managed only 173 minutes. With motor blocks, dexmedetomidine showed some advantages by sustaining it better: chronicling 188 minutes of sustenance as opposed to the other group that administered Clonidine which only had 138 minutes. Overall results support prior literature suggesting primary adjunct medications like dexmedetomidine tend to augment bupivacaine's effect by not only starting them quickly but also prolonging their effects. It has also been suggested that time to first rescue analgesia, a distinctly sharp measure of pain control efficiency after surgery suggests worse performance for the dexmedetomidine cohort. While patients in Group BD achieved their first dose approximately 255 minutes post spinal block, those in Group BC used it around 206 minutes. This increased duration of enjoying such analgesic value supports the assumption that the use of dexmedetomidine improves postoperative pain management.

To summarize, the data within this study demonstrates that intrathecal dexmedetomidine not only increases the rate at which blocks are set and anesthetic effects are sustained but also provides a longer duration of analgesic effects in comparison to clonidine. These findings support its utilization as an adjunct for spinal anesthesia in dexmedetomidine lower abdominal surgeries. [Table 1 & Figure 1]

Table 1: Onset and Duration of Sensory and Motor Block

Parameter	Group BC (Mean ± SD)	Group BD (Mean ± SD)	p-value
Onset of Sensory Block (min)	4.6 ± 1.1	3.2 ± 0.9	<0.001
Onset of Motor Block (min)	6.1 ± 1.4	4.5 ± 1.1	<0.001
Duration of Sensory Block (min)	173 ± 22	223 ± 24	<0.001
Duration of Motor Block (min)	138 ± 18	188 ± 21	<0.001
Time to First Rescue Analgesia (min)	206 ± 25	255 ± 27	<0.001

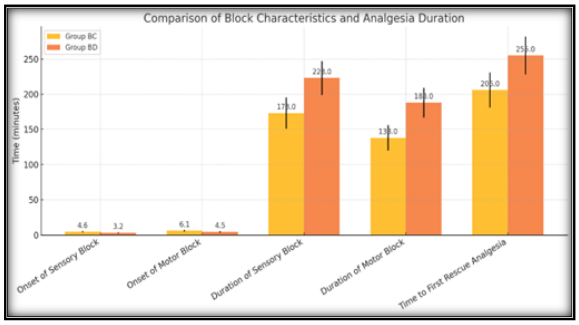

Figure 1: Onset and Duration of Sensory and Motor Block

Comparison of hemodynamic parameters between the two groups showed that patients in the dexmedetomidine group demonstrated greater intraoperative heart rate and mean arterial pressure reduction.

The lowest heart rate was significantly lower in Group BD (59 ± 7 bpm) than Group BC (64 ± 6 bpm), with p value = 0.02. This indicates that dexmedetomidine dosed intrathecally shows stronger bradycardic response relative to clonidine.

The lowest MAP recorded during surgery was also greater in the verb's group as compared to its counterpart: dexmedetomidine group 70 ± 6 mmHg, clonidine group 74 ± 5 mmHg, p=0.01 – thus suggesting stronger hypotensive effect associated with dexmedetomidine.

Despite significant decremental changes noted on standard cardiovascular measurements, the absolute values attained were still within a reasonable range clinically and can be treated using routine methods. No subjects ceased interventions because of unstable key performance indicators through blood pressure measurement techniques.

In summary, although both adjuvants sustained stable intraoperative profiles, dexmedetomidine use was linked not only to steady rates of hypertension but also a consistent albeit small decrease indicating efficacy south vasoconstrictor center sympatholytic actions.

Both groups maintained stable hemodynamic parameters. However, mild bradycardia and hypotension was more frequent in Group BD.

Table 2: Comparison of Hemodynamic parameters in both the groups.

Parameter	Group BC (Mean ± SD)	Group BD (Mean ± SD)	p-value
Lowest HR (bpm)	64 ± 6	59 ± 7	0.02
Lowest MAP (mmHg)	74 ± 5	70 ± 6	0.01

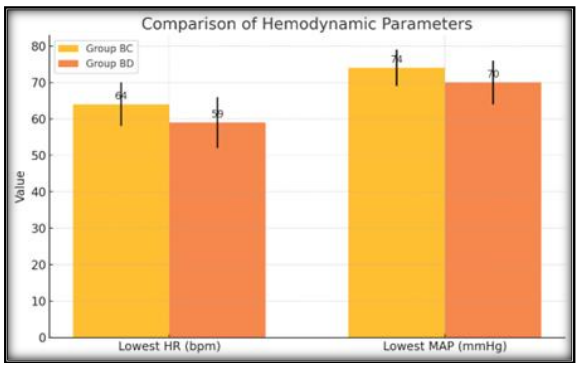

Figure 2: Comparison of Hemodynamic parameters in both the groups

In the comparison with Clonidine, participants assigned dexmedetomidine infusion showed significantly elevated sedation scores 30 minutes after receiving spinal anesthesia.

Within this timeframe, the mean Ramsay Sedation Score (RCT) for Group BD was 3.1 ± 0.5 while for Group BC it was 2.2 ± 0.4 and p value <0.001 was recorded which indicates difference is significant statistically too [Table 3].

Table 3: Sedation Score (Ramsay Sedation Scale)

Time Interval	Group BC (Mean ± SD)	Group BD (Mean ± SD)	p-value
30 min post-spinal	2.2 ± 0.4	3.1 ± 0.5	<0.001

Adverse events were reported in both groups, although more common in the dexmedetomidine group. Hypertension was seen in 21.4% of patients in Group BD compared to 10.7% in Group BC. In the dexmedetomidine group, bradycardia was noted in 14.3%. This contrasts sharply with the clonidine subgroup where only 3.6% experienced this effect. Such results correlate well with the sympatholytic effects and dose-dependent cardiovascular depression associated with dexmedetomidine.

The occurrence of nausea and vomiting was slightly greater for Group BD (10.7%) compared to Group BC (7.1%); however, no clear difference could be established between the two groups that would reveal a significant divergence from one another. Noteworthy is that neither pruritus nor any form of respiratory complications arose within either group.

All side effects described remained mild and did not require active treatment or cessation of procedures therein refraining from intervention or requiring suspension of the procedure undertaken without needing to intervene or signal a stop on the work being performed. In summary, while hypotension and bradycardia occurred more often with dexmedetomidine use, all adverse events were managed easily within clinically safe thresholds thus reinforcing its efficacy when used intrathecally as an adjunct medication provided adequate safeguards are in place during its administration.

Table 4: Comparison of adverse effects in both the groups.

Adverse Event	Group BC (n, %)	Group BD (n, %)
Hypotension	3 (10.7%)	6 (21.4%)
Bradycardia	1 (3.6%)	4 (14.3%)
Nausea/Vomiting	2 (7.1%)	3 (10.7%)
Pruritus	0	0
Respiratory issues	0	0

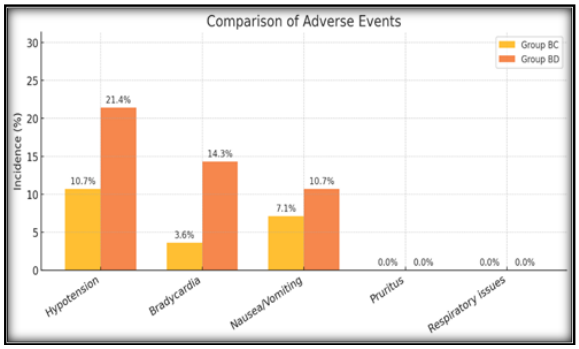

Figure 3: Comparison of adverse effects in both the groups.

DISCUSSION

This study assesses the effectiveness of intrathecal administration of clonidine and dexmedetomidine as adjuncts to bupivacaine in patients undergoing lower abdominal surgeries. The results showed that dexmedetomidine not only provided a quicker onset but also extended the duration of both sensory and motor blockade, while providing longer postoperative analgesia as compared to clonidine. Both drugs were safe in their use.

As reviewed by Elia et al there is sufficient evidence that supports the claim that intrathecal adjuvants, such as clonidine, significantly increase the effectiveness and duration of provided analgesics while reducing overall consumption of rescue analgesics. Although beneficial, the authors also pointed out high rates of bradycardia and hypotension within these studies. For our study participants who received clonidine, bradycardia and hypotension was seen in 3.6% and 10.7% respectively, which seemingly contrasts with the 21.4% and 14.3% rate noted for dexmedetomidine suggesting that all agents need cardiovascular monitoring during administration.[11]

Kaur et al evaluated a comparative efficacy study in patients receiving epidural anesthesia indicating that dexmedetomidine produced faster onset of block than with continuous infusion of low dose clonidine.[12] Furthermore, their findings corroborate ours where the onset of sensory block was markedly faster with dexmedetomidine (3.2 min vs 4.6 min) and lasting too (255 min vs 206).

Strebel et al showed in their dose-response study involving intrathecal clonidine and isobaric bupivacaine that even minimal dosing resulted in significant spinal block duration prolongation.[13] Our work is supportive of clonidine's ability to prolong the block, although in this case dexmedetomidine seemed to exert a greater effect suggesting perhaps increased potency.

In a randomized trial Dobrydnjov et al assessed the use of intrathecal clonidine with low-dose bupivacaine for herniorrhaphy focusing on analgesic effectiveness alongside systemic hemodynamic stability.[14] While using standard doses of bupivacaine, we also observed that administration of clonidine was effective and well tolerated, although dexmedetomidine provided added advantages regarding duration of blockade as well as sedation.

Mahendru et al comparing intrathecal adjuvants fentanyl, clonidine and dexmedetomidine reported the latter produced the longest motor and sensory block whilst providing better sedation and fewer side effects. The duration of analgesia they reported (250 – 270 min) is strikingly similar to our observation of 255 ± 27 minutes in the dexmedetomidine group.[15]

A lower limb amputation study conducted by Ismaila et al demonstrated that dexmedetomidine significantly improved postoperative stump pain compared to fentanyl. While differing in surgical context, our findings regarding prolonged analgesic effect with dexmedetomidine align with theirs.[16]

Khan et al noted that dexmedetomidine provided faster onset with higher sedation scores and longer duration than fentanyl for lower abdominal surgeries. Increments to intraoperative comfort appear probable from our 30-minute sedation score of 3.1 ± 0.5 with dexmedetomidine in comparison to the surgical comfort.[17]

Patro et al reported that dexmedetomidine both improved the infraumbilical block's sensory and motor components while also increasing the time until rescue analgesia was required. Their sensory block duration of 223 min, along with time to rescue of 255 min is close enough to our estimates as to further validate those results.[18]

Sarma et al., in a head-to-head comparison, claimed that dexmedetomidine was superior to clonidine concerning block duration and sedation through a claimed lack of major side effects.[19] Our findings aligned with theirs corroborating use preference for dexmedetomidine.

Lastly, a thesis study by Dhingra suggested that patients receiving dexmedetomidine exhibited greater satisfaction and more uniform block characteristics than those given clonidine which reinforces our conclusions regarding using intrathecal adjuvants.[20]

In this case, a single center design stands out as the primary limitation which weakens the external validity of the study. Although adequate, the sample size was small and has a high likelihood of missing rare adverse effects.

CONCLUSION

This investigation showed that intrathecal dexmedetomidine, as an adjuvant to bupivacaine, resulted in more rapid onset, extended duration of both sensory and motor block as well as postoperative analgesia when compared to clonidine in lower abdominal surgeries. While there was a slightly increased incidence of hypotension and bradycardia with dexmedetomidine use, these complications were manageable from a clinical standpoint. Although overall sedation levels were higher than with clonidine, they remained within acceptable ranges. In summary, dexmedetomidine demonstrated greater effectiveness and reliability than clonidine as an intrathecal adjuvant, improving the quality of spinal anesthesia while maintaining the safety of the patient.

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