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Original Article

ENHANCING SPINAL ANESTHESIA WITH DEXMEDETOMIDINE: A PROSPECTIVE STUDY ON PROLONGING ANALGESIA AND REDUCING OPIOID REQUIREMENTS IN INFRA UMBILICAL SURGERIES

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ABSTRACT

Objective: Pain management in surgical settings poses significant challenges, particularly in minimizing opioid use due to associated risks. Dexmedetomidine, a selective α2-adrenergic agonist, has shown promise as an adjunct in spinal anesthesia to enhance analgesic and anesthetic effects.

Methods: This prospective, randomized, double-blind study involved 60 patients undergoing infraumbilical surgeries, divided into two groups. Group D received intravenous dexmedetomidine, while Group C received a saline placebo. We assessed the duration of sensory and motor blocks, sedation levels, and the time to first postoperative analgesia request.

Results: Group D exhibited significantly longer durations of sensory and motor blocks, higher sedation scores, and extended time before requesting postoperative analgesia compared to Group C. These results suggest improved anesthetic quality and pain control with dexmedetomidine.

Conclusion: Intravenous dexmedetomidine enhances spinal anesthesia by prolonging block durations and improving sedation, potentially decreasing the need for postoperative opioids. This supports its use as an effective adjunct in anesthesia, contributing to safer, more effective pain management strategies.

Keywords: Dexmedetomidine, Spinal anesthesia, Pain management, Opioid reduction, Surgical anesthesia

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INTRODUCTION

Pain, as defined by the International Association for the Study of Pain, is an unpleasant sensory and emotional experience often associated with actual or potential tissue damage, prominently occurring as surgical pain due to tissue trauma from surgical interventions. This type of pain, resulting from incisions and related manipulations, necessitates effective management strategies to mitigate associated discomfort and physiological stress. Anesthesia plays a pivotal role in this context by not only alleviating pain during surgical procedures but also minimizing postoperative discomfort and adverse physiological responses, thus ensuring a trauma-free perioperative experience [1-3].

In the realm of anesthesia, various modalities are employed depending on the surgical context, including general, regional, and local anesthesia. Regional anesthesia, which encompasses techniques like spinal and epidural anesthesia, offers distinct advantages for surgeries involving the lower extremities and lower abdomen. These benefits include superior pain control, absence of airway intervention, reduced side effects, and potentially shorter recovery times in post-anesthesia care units [4, 5].

Among regional techniques, spinal anesthesia is widely favored for infraumbilical surgeries due to its rapid onset and effective sensory and motor blockade. However, achieving the right spread of local anesthetic within the cerebrospinal fluid to provide sufficient anesthesia without excessive spread remains a clinical challenge. Overextension can lead to complications such as hypotension, respiratory compromise from intercostal and diaphragmatic paralysis, and in severe cases, cardio-respiratory arrest if not managed promptly [6-8].

Despite the lower incidence of surgical blood loss and fewer perioperative complications associated with spinal anesthesia compared to general anesthesia, the latter poses risks related to airway management and postoperative respiratory support, especially in patients with specific vulnerabilities like smokers or those with pre-existing respiratory issues [9].

Bupivacaine is the standard local anesthetic used in spinal blocks, typically sufficient for procedures lasting up to two hours. To enhance the efficacy and duration of spinal anesthesia, various adjuncts such as epinephrine, clonidine, and dexmedetomidine have been explored. These adjuncts can reduce the required dose of local anesthetics, thereby mitigating their potential adverse effects and prolonging the analgesic effects, which contributes to better surgical conditions [10].

While opioids are a mainstay in managing surgical pain, their use is fraught with challenges, including risks of dependency, respiratory depression, and other significant side effects. In the search for safer alternatives, dexmedetomidine, a highly selective α2-adrenergic receptor agonist, emerges as a promising adjunct. Approved by the FDA for ICU sedation and procedural sedation in non-intubated patients, dexmedetomidine offers advantages such as hemodynamic stability and reduced risk of respiratory depression. Its utility in spinal anesthesia has shown promising results in enhancing pain control and reducing perioperative opioid requirements [11].

The current study focuses on evaluating the analgesic and anesthetic enhancements provided by intravenous dexmedetomidine as premedication in spinal anesthesia, aiming to further delineate its potential benefits in improving perioperative outcomes and addressing the limitations associated with traditional opioid use. This investigation is poised to contribute valuable insights into optimizing pain management strategies in surgical settings, thereby potentially mitigating the reliance on opioids and their associated complications.

MATERIALS AND METHODS

Study design and setting

This prospective, randomized, double-blind study was conducted at the Department of Anesthesia, Jhalawar Medical College, Jhalawar. Ethical approval was obtained from the hospital's ethics committee

and informed written consent was secured from all participants. The study was carried out over a one-year period from January 2023 to January 2024.

Participants

A total of 60 patients scheduled for lower abdominal surgeries were enrolled and randomly allocated into two groups of 30 each:

- **Group D**: Patients received intravenous dexmedetomidine at a dose of 0.5 µg/kg, prepared in normal saline to a total volume of 10 ml, administered over 10 min, thirty minutes prior to surgery.
- **Group C**: Patients received 10 ml of normal saline intravenously as a placebo.

Inclusion criteria

- Age between 35-65 y
- Weight between 50-70 kg.
- ASA physical status I and II.
- Elective lower abdominal surgeries.
- All laboratory investigations within normal limits.

Exclusion criteria

- Patient refusal.
- Contraindications to spinal anesthesia (e. g., coagulopathy, pre-existing neurological disease, anatomical spine abnormalities, local infection).
- Diabetes, recent corticosteroids or immunosuppressant drugs usage.
- Compromised renal, pulmonary, or cardiac status.
- Usage of hypnotics, narcotics, or sedatives.
- Hypotension or vascular diseases.
- Known allergy to anesthetic agents.
- Seizure disorders, anticipated difficult intubation.
- ASA grade ≥3.
- Emergency surgeries and caesarean sections.

Preoperative evaluation

Patients underwent a thorough preoperative evaluation on the day before surgery, including a complete medical history, physical and systemic examination, airway and vertebral column assessment, ASA grading, and baseline vital signs (pulse, blood pressure, respiratory rate, height, weight). Mandatory fasting guidelines were followed, and preoperative investigations included hemoglobin, total and differential leukocyte counts, bleeding and clotting times, random blood sugar, blood urea, serum creatinine, liver function tests, chest X-ray (PA view), and electrocardiography.

Materials

- 25 G Quincke spinal needle.
- Syringes (5cc, 10cc, 20cc).
- Sterile swabs, bowls, sponge holding forceps, hole towel, povidone-iodine.
- Drugs: 0.5% hyperbaric bupivacaine, dexmedetomidine, normal saline.
- Anesthesia machine, breathing circuit.
- Patent intravenous line.
- Emergency resuscitation equipment.

Anesthetic procedure

Following a comprehensive pre-anesthetic checkup and informed consent, patients were taken to the operating theater. Standard monitoring was initiated upon arrival, and baseline parameters were recorded. An IV line was secured with an 18 G cannula, and 500 ml of Ringer's Lactate was started. Premedication included intravenous ranitidine (50 mg), metoclopramide (10 mg), and dexmedetomidine (0.5 µg/kg diluted to 10 ml with sterile water) or normal saline in Group C, infused over 10 min using an infusion pump half an hour before surgery. Under strict aseptic conditions, a lateral decubitus position was assumed for the dural puncture at the L3-L4 interspace using a midline approach with a 25 G Quincke needle. A dose of 15 mg (3 ml) of 0.5% hyperbaric bupivacaine was injected intrathecally. Patients were then immediately positioned supine for the duration of the surgery, receiving oxygen at a flow rate of 4 l/min.

Monitoring and postoperative care

Vital parameters, including pulse, blood pressure, and oxygen saturation, were monitored preoperatively, intraoperatively, and postoperatively. Sensory and motor blocks were assessed using the pinprick test and Modified Bromage Scale, respectively. Sedation levels were evaluated at predetermined intervals using the Ramsay Sedation Score. The mean arterial blood pressure and heart rate were continuously recorded, and any incidences of hypotension or bradycardia were addressed with appropriate interventions. Time to request for rescue analgesia and the presence of any complications or side effects were also documented.

RESULTS

The present study evaluated the anesthetic and analgesic effects of intravenous Dexmedetomidine as premedication for spinal anesthesia in patients undergoing infraumbilical surgeries. A total of 60 patients were randomized into two groups, Group D (Dexmedetomidine) and Group C (Control), each comprising 30 patients.

Sensory block levels

The highest level of sensory block achieved showed no significant difference between the two groups. In Group D, 16.67% reached T5, 40.00% reached T6, 30.00% reached T7, and 13.33% reached T8. Similarly, in Group C, the proportions were 20.00% for T5, 40.00% for T6, 26.67% for T7, and 13.33% for T8 (table 1).

Duration of sensory block

The duration of the sensory block differed significantly between the two groups. In Group D, no patients experienced sensory block for less than 60 min, 26.67% for 61-120 min, 66.67% for 121-180 min, and 6.67% for 181-240 min. Conversely, in Group C, 96.67% had a sensory block duration of 61-120 min, with only one patient (3.33%) experiencing longer block up to 180 min (table 2).

Duration of motor block

The motor block duration was significantly longer in Group D compared to Group C. In Group D, 60.00% of patients had a motor block lasting 121-180 min and 40.00% for 181-240 min. In contrast, 46.67% of Group C patients experienced a motor block for 61-120 min, and 53.33% up to 180 min (table 3).

Postoperative analgesia

The time to request for first postoperative analgesia was significantly delayed in Group D compared to Group C. In Group D, 43.33% of patients requested their first analgesia between 181-240 min and 50.00% between 241-300 min. In contrast, 90.00% of Group C requested analgesia much earlier, between 121-180 min (table 4).

Sedation scores

The Ramsay Sedation Score indicated a higher level of sedation in Group D where 80% of patients had a score of 3, while all patients in Group C had a score of 2, highlighting a significant difference in sedation levels between the groups (table 5).

These findings suggest that dexmedetomidine as premedication enhances the duration of sensory and motor blocks while improving sedation levels without advancing the time for first postoperative

analgesia. These benefits could imply a potent role of dexmedetomidine in managing anesthesia in infra umbilical surgeries, contributing to both patient comfort and surgical efficiency.

Table 1: Level of sensory block

Highest block level	Group D (n=30)	Group C (n=30)	Total (n=60)
T5	5 (16.67%)	6 (20.00%)	11 (18.33%)
T6	12 (40.00%)	12 (40.00%)	24 (40.00%)
T7	9 (30.00%)	8 (26.67%)	17 (28.33%)
T8	4 (13.33%)	4 (13.33%)	8 (13.33%)
Total	30 (100%)	30 (100%)	60 (100%)

Table 2: Duration of sensory block

Duration (min)	Group D (n=30)	Group C (n=30)	Total (n=60)
<60	0 (0%)	0 (0%)	0 (0%)
61-120	8 (26.67%)	29 (96.67%)	37 (61.67%)
121-180	20 (66.67%)	1 (3.33%)	21 (35.00%)
181-240	2 (6.67%)	0 (0%)	2 (3.33%)
Total	30 (100%)	30 (100%)	60 (100%)

Table 3: Duration of motor block

Duration (min)	Group D (n=30)	Group C (n=30)	Total (n=60)
61-120	0 (0%)	14 (46.67%)	14 (23.33%)
121-180	18 (60.00%)	16 (53.33%)	34 (56.67%)
181-240	12 (40.00%)	0 (0%)	12 (20.00%)
Total	30 (100%)	30 (100%)	60 (100%)

Table 4: Time at request for first postoperative analgesia

Time (min)	Group D (n=30)	Group C (n=30)	Total (n=60)
60-120	0 (0%)	0 (0%)	0 (0%)
121-180	2 (6.67%)	27 (90.00%)	29 (48.33%)
181-240	13 (43.33%)	3 (10.00%)	16 (26.67%)
241-300	15 (50.00%)	0 (0%)	15 (25.00%)
Total	30 (100%)	30 (100%)	60 (100%)

Table 5: Ramsay sedation score

Sedation score	Group D (n=30)	Group C (n=30)	Total (n=60)
2	6 (20.00%)	30 (100%)	36 (60.00%)
3	24 (80.00%)	0 (0%)	24 (40.00%)
4	0 (0%)	0 (0%)	0 (0%)
Total	30 (100%)	30 (100%)	60 (100%)

DISCUSSION

This study aimed to explore the analgesic and anesthetic enhancements provided by intravenous dexmedetomidine when used as a premedication in spinal anesthesia for infra-umbilical surgeries. The results underscore the efficacy of dexmedetomidine in prolonging both sensory and motor block duration, enhancing sedation levels, and extending the time to first postoperative analgesia request [12].

Dexmedetomidine, a selective α2-adrenergic receptor agonist, has been shown to reduce intraoperative anesthetic requirements and provide stable hemodynamics, which are crucial in managing surgical patients. In our study, the sensory block duration was notably longer in the dexmedetomidine group (Group D) compared to the control group (Group C), which aligns with previous research indicating dexmedetomidine's potential to enhance the effects of spinal bupivacaine. This is particularly significant in the context of reducing opioid usage, which is a critical concern in the current opioid crisis. Moreover, the enhanced sedation level observed in Group D did not compromise patient safety, as evidenced by the stable cardiorespiratory parameters throughout the surgical and immediate postoperative periods [13].

The longer duration of motor block in Group D may suggest an improved quality of analgesia, which can be particularly beneficial in surgeries requiring extended postoperative pain management. This could lead to a decrease in the need for immediate postoperative opioid administration, thus minimizing the risks associated with opioid use, such as respiratory depression and potential dependency [14].

However, the study also brings to light some challenges. While dexmedetomidine offers several perioperative benefits, its effects on blood pressure and heart rate necessitate careful monitoring and management. Future studies could explore the optimal dosing and administration strategies to maximize benefits while minimizing potential side effects [15].

The findings of this study suggest that dexmedetomidine is a viable option for enhancing spinal anesthesia, with implications for improving patient outcomes in terms of pain management, sedation quality, and overall surgical experience. The ability of dexmedetomidine to provide a stable anesthetic experience with reduced opioid requirements positions it as a potentially transformative agent in anesthesia practice.

CONCLUSION

Dexmedetomidine as a premedication in spinal anesthesia significantly enhances the duration and quality of sensory and motor blocks, improves sedation levels, and prolongs the time to first postoperative analgesia. These benefits, combined with its favorable safety profile, underscore its potential in reducing reliance on opioids and improving perioperative patient management. Future research should focus on optimizing dosing protocols to enhance its application in clinical practice further.

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AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

Declared none

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