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Original research article

COMPARISON OF THE EFFECT OF DEXMEDETOMIDINE AND TRAMADOL AS AN ADJUNCT WITH BUPIVACAINE ON THE DURATION OF SPINAL ANESTHESIA

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Abstract: *Spinal anesthesia is a commonly employed technique for infra-umbilical surgeries, but its duration is often insufficient for prolonged procedures. Adjuvants such as dexmedetomidine and tramadol are used to enhance its efficacy. This study aimed to compare the effects of dexmedetomidine and tramadol as adjuvants to bupivacaine in spinal anesthesia.* ***Methods:*** *This randomized controlled trial was conducted at the Department of Anesthesia, AIMC, Jinnah Hospital, Lahore, over one year From 2021 to 2022. 68 patients undergoing elective infraumbilical surgeries were randomized into two groups. Group A received 7 µg dexmedetomidine with 12 mg bupivacaine, and Group B received 25 mg tramadol with 12 mg bupivacaine. Outcomes assessed included the onset of sensory block, total duration of analgesia, time to first rescue analgesia, and intraoperative and postoperative pain scores. Statistical analyses were performed using SPSS version 25, with a p-value <0.05 considered significant.* ***Results:*** *The mean onset of sensory block was significantly shorter in the dexmedetomidine group (6.6 ± 0.603 minutes) compared to the tramadol group (7.2 ± 0.825 minutes; p = 0.002). The total duration of analgesia was significantly longer in the dexmedetomidine group (14.4 ± 1.16 hours) compared to the tramadol group (10.6 ± 1.02 hours; p < 0.001). Similarly, the mean time to first rescue analgesia was significantly prolonged in the dexmedetomidine group (11.8 ± 0.967 hours) compared to the tramadol group (7.9 ± 0.924 hours; p < 0.001). Intraoperative and postoperative pain scores were consistently lower in the dexmedetomidine group, with statistically significant differences at 2, 3, 5, and 6 hours.* ***Conclusion:*** *Dexmedetomidine is a more effective adjuvant than tramadol in spinal anesthesia, offering a shorter onset of sensory block, prolonged analgesic duration, and delayed rescue analgesia with better pain control. These results support the use of dexmedetomidine as a preferred adjuvant for extended surgical procedures under spinal anesthesia. Future studies with larger sample sizes are recommended to validate these findings further.*

Keywords: Spinal anesthesia, dexmedetomidine, tramadol, bupivacaine, infra umbilical surgeries, analgesia duration, rescue analgesia.

Introduction

Spinal anesthesia is widely utilized for surgical procedures due to its effectiveness in providing intraoperative analgesia and its associated benefits, such as reduced metabolic stress, minimal postoperative complications, and faster recovery times. However, one of its major limitations is the relatively short duration of its effects, often necessitating additional interventions or medications to extend the analgesic duration for prolonged surgeries (1, 2). Among the various local anesthetics, bupivacaine is commonly used due to its long-acting properties. Nevertheless, its duration of action, typically lasting 1.5 to 2 hours, can be insufficient for longer surgeries, necessitating the use of adjuvants (3).

Adjunct medications like opioids and alpha-2 adrenergic agonists have been explored to enhance the effects of local anesthetics. Tramadol, a synthetic opioid, and dexmedetomidine, a highly selective alpha-2 adrenergic receptor agonist, are two such agents known for their potential to prolong the effects of bupivacaine when used intrathecally (4, 5). Tramadol exerts its analgesic effects by activating opioid receptors and inhibiting serotonin and norepinephrine reuptake, while dexmedetomidine offers both analgesic and sedative effects through its action on alpha-2 adrenergic receptors (6).

Recent studies have compared the efficacy of these agents as adjuvants, with evidence suggesting that dexmedetomidine may offer superior prolongation of analgesia and reduced postoperative rescue analgesic requirements compared to tramadol (7, 8). However, the choice between these agents remains a topic of debate, particularly in clinical settings where optimal outcomes in terms of sensory block onset, analgesic duration, and side effect profile are critical. The lack of localized data further underscores the need for comparative studies in different populations.

This study aims to compare the effects of dexmedetomidine and tramadol as adjuvants to bupivacaine in prolonging the duration of spinal anesthesia. By evaluating sensory block onset, analgesia duration, and the time to first rescue analgesia, this research seeks to identify the more effective agent for enhancing spinal anesthesia outcomes in infra-umbilical surgeries.

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Methodology

The study was a randomized controlled trial conducted at the Department of Anesthesia, AIMC, Jinnah Hospital, Lahore, over one year following the approval of the synopsis. 68 patients, aged between 20 and 60 years, undergoing elective infraumbilical surgeries were included. Participants were recruited through non-probability convenience sampling and randomly allocated into two groups using the lottery method. Group A received 7 µg of dexmedetomidine with 12 mg of bupivacaine, while Group B received 25 mg of tramadol with 12 mg of bupivacaine. All patients provided written informed consent before inclusion.

Preoperative evaluations were conducted the day before surgery, focusing on obtaining detailed medical histories, including diabetes, hypertension, respiratory conditions, drug sensitivities, and prior anesthesia experiences. Physical examinations assessed weight, nutritional health, and airways using the Mallampati grading system. Cardiovascular, respiratory, and central nervous system assessments were performed alongside routine preoperative laboratory tests. Patients were advised to remain nil per oral (NPO) for six hours before the procedure.

On the day of surgery, participants were randomized into their respective groups. In the operating theatre, standard monitoring devices, including a pulse oximeter, blood pressure cuff, and ECG electrodes, were attached, and baseline vital signs were recorded. Under aseptic conditions, spinal anesthesia was administered using a 25G Quincke needle inserted at the L3–L4 level. After confirming the backflow of cerebrospinal fluid, the prefilled study drugs were administered as per group allocation. The onset of sensory block was assessed by pinprick at the T10 level, and surgery commenced once sensory loss at this level was confirmed. Blood pressure measurements, including systolic, diastolic, and mean arterial pressure (MAP), were recorded at regular intervals of 3, 5, 10, 20, and 30 minutes following spinal anesthesia administration.

Pain was assessed intraoperatively and postoperatively using the Visual Analogue Scale (VAS) at hourly intervals for six hours. If the VAS score exceeded 3, indicating mild to moderate pain, supplemental analgesia was administered. The time to first rescue analgesia was noted, and an injection of nalbuphine (2 mg IV) was given if required. In cases where the spinal block was insufficient, preparations for general anesthesia were made as a backup plan.

Data analysis was conducted using SPSS version 25. Quantitative variables, such as age, were presented as mean ± standard deviation (SD), while qualitative variables, such as gender, were presented as frequencies and percentages. Comparative analysis between the two groups for onset of sensory block, total duration of analgesia, and time to first rescue analgesia was performed using an independent t-test. A p-value of less than 0.05 was considered statistically significant. The findings aimed to determine which adjuvant, dexmedetomidine or tramadol, was more effective in prolonging the anesthetic effects of bupivacaine in spinal anesthesia.

Results

A total of 68 patients were enrolled. The mean age (in years) in the dexmedetomidine group was 40±7.76 and in the tramadol group was 41±7.08 (Table 1). Concerning gender, in the dexmedetomidine group, there were 21 (31%) males and 13 (19%) females and in the tramadol group, there were 17 (25%) males and 17 (25%) females. In terms of ASA grade, 10 (15%) had ASA grade 1 in the dexmedetomidine group compared to 11 (16%) in the tramadol group, and ASA grade II status was seen in 24 (35%) patients in the dexmedetomidine group compared to 23 (34%) patients in the tramadol group (Figure 1).

Table 1: Mean age of patients in both groups

GROUP	N	MEAN±STANDARD DEVIATION
Group A (Dexmedetomidine)	34	40 ±7.76
Group B (Tramadol)	34	41 ±7.08

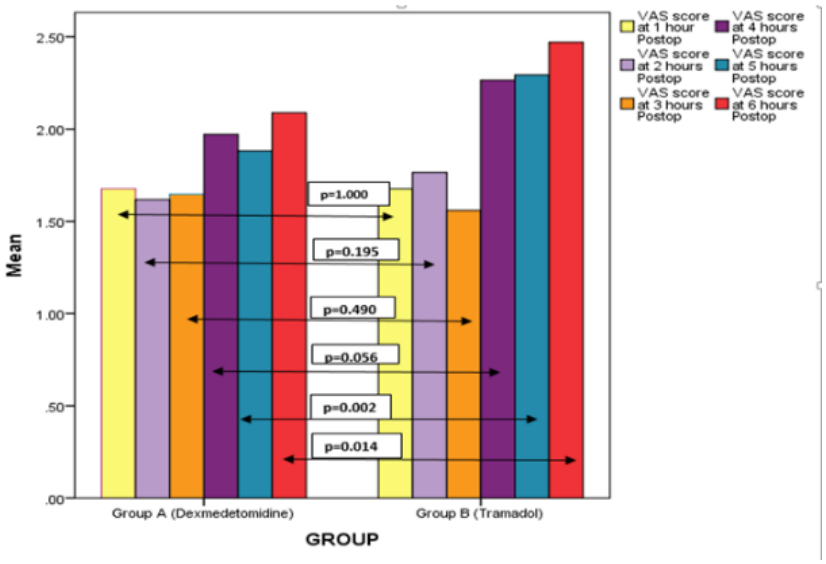

Figure 1: Distribution of patients according to ASA grade in both groups

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In terms of mean VAS pain score intraoperatively at 0, 1, 2, and 3 hours, it was revealed that in the Dexmedetomidine group, it was 0.26, 0.21, 0.06, and 0.12 respectively. In the Tramadol group, it was 0.21, 0.26, 0.32, and 0.32 respectively and the difference in the mean intraoperative VAS pain score was statistically significant at 2 and 3 hours i.e. p <0.05 (Figure 2).

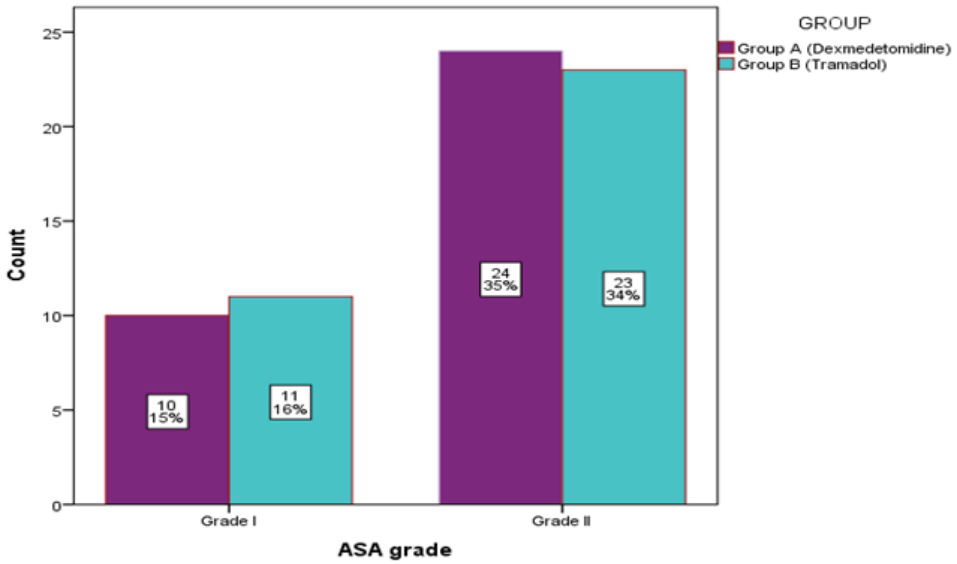

Figure 2: Comparison of both groups in terms of mean intraoperative pain vas score

The mean postoperative VAS pain score at 1, 2, 3,4,5, and 6 hours in the dexmedetomidine versus tramadol group was 1.7 versus 1.7, 1.6 versus 1.8, 1.6 versus 1.6, 1.9 versus 2.2, 1.9 versus 2.3, and 2.1 versus 2.5, respectively and the difference was only significant statistically at 5 and 6 hours i.e. p<0.05 (Figure-3).

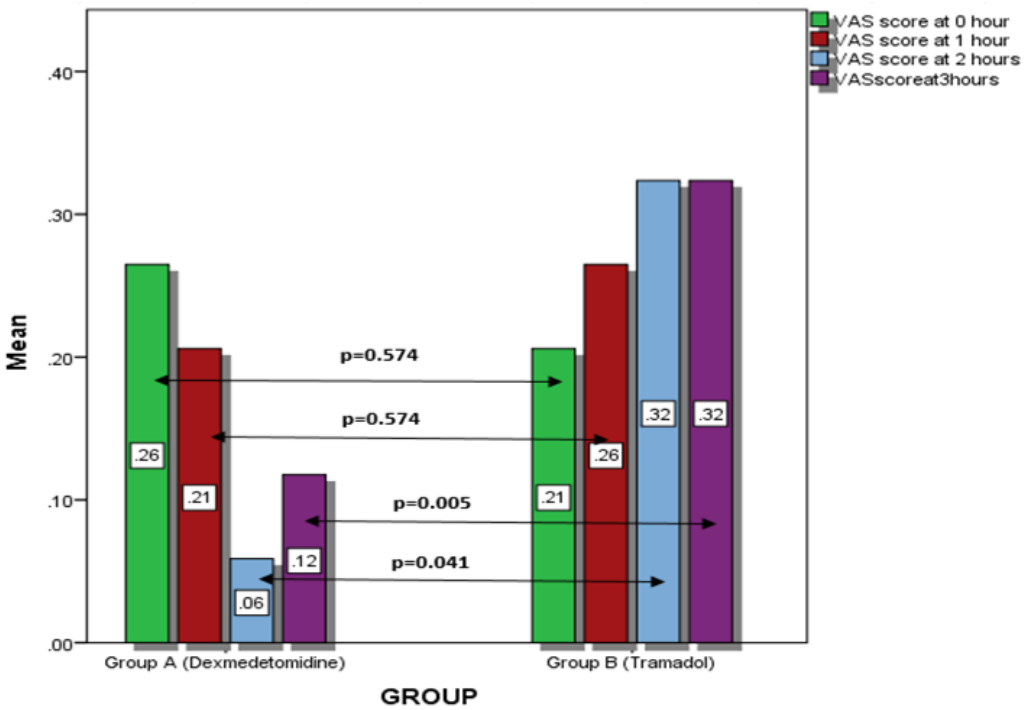

Figure 3 Comparison of mean postoperative vas scores at different intervals between the two groups

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Table 2: Comparison of Mean Onset of Sensory Block, Total Duration of Analgesia, and Time to First Rescue Analgesia Between Groups

Variable	Group A (Dexmedetomidine)	Group B (Tramadol)	Mean Difference	p-value
Mean Onset of Sensory Block (minutes)	6.6 ± 0.603	7.2 ± 0.825	-0.60	0.002
Mean Total Duration of Analgesia (hours)	14.4 ± 1.16	10.6 ± 1.02	+3.80	<0.001
Mean Time to First Rescue Analgesia (hours)	11.8 ± 0.967	7.9 ± 0.924	+3.90	<0.001

The results revealed a significant difference in the onset of sensory block between the two groups. The mean onset time was 6.6 ± 0.603 minutes in the dexmedetomidine group compared to 7.2 ± 0.825 minutes in the tramadol group, with a mean difference of -0.60 minutes. The t-test analysis confirmed this difference as statistically significant ($t = -3.287$, $p = 0.002$). Similarly, the mean total duration of analgesia was notably longer in the dexmedetomidine group, at 14.4 ± 1.16 hours, compared to 10.6 ± 1.02 hours in the tramadol group. The mean difference of +3.80 hours was highly significant ($t = 13.766$, $p < 0.001$).

Discussion

This study aimed to compare the effects of dexmedetomidine and tramadol as adjuvants to bupivacaine in spinal anesthesia for infra-umbilical surgeries. The findings demonstrated significant differences between the two groups in terms of onset of sensory block, total duration of analgesia, and time to first rescue analgesia, favoring dexmedetomidine as a more effective adjuvant.

The mean onset of sensory block was significantly shorter in the dexmedetomidine group (6.6 ± 0.603 minutes) compared to the tramadol group (7.2 ± 0.825 minutes). These findings align with those reported by Gupta and Sharma (2017), who also observed a quicker onset of sensory block with dexmedetomidine compared to tramadol when combined with bupivacaine (9). The enhanced efficacy of dexmedetomidine can be attributed to its highly selective alpha-2 adrenergic receptor agonist activity, which facilitates pre-synaptic inhibition of neurotransmitter release and potentiates the effects of bupivacaine (6).

The mean total duration of analgesia was significantly prolonged in the dexmedetomidine group (14.4 ± 1.16 hours) compared to the tramadol group (10.6 ± 1.02 hours). This result is consistent with previous studies, such as those conducted by Nasr and Waly (2021), who reported a significantly longer duration of analgesia with dexmedetomidine than tramadol (7). Dexmedetomidine's prolonged analgesic effect is thought to be mediated through hyperpolarization of nerve cells, reducing their excitability and extending sensory and motor blockade (10).

The mean time to first rescue analgesia was also significantly longer in the dexmedetomidine group (11.8 ± 0.967 hours) compared to the tramadol group (7.9 ± 0.924 hours). These findings are in line with those of Singh et al. (2023), who demonstrated that dexmedetomidine significantly delays the need for additional analgesia compared to tramadol (4). Tramadol, while effective, primarily acts through opioid receptor activation and monoaminergic pathways, which may not sustain prolonged analgesia as effectively as the mechanisms of dexmedetomidine (11).

The intraoperative and postoperative VAS pain scores further support the superiority of dexmedetomidine. While both groups experienced low pain scores initially, the dexmedetomidine group maintained significantly lower scores at later intervals, particularly at 2 and 3 hours intraoperatively and 5 and 6 hours postoperatively. This observation corroborates the findings of Elyazed and Mostafa (2022), who reported lower VAS pain scores in patients receiving dexmedetomidine as an adjuvant to bupivacaine (8).

The demographic characteristics, including age, gender distribution, and ASA grades, were comparable between the two groups, ensuring that the observed differences were due to the pharmacological effects of the adjuvants. These results emphasize the clinical utility of dexmedetomidine in enhancing the quality and duration of spinal anesthesia, making it a valuable adjuvant for longer surgical procedures.

Overall, our study aligns with existing literature, reinforcing the advantages of dexmedetomidine over tramadol when used with bupivacaine. However, further multicenter studies with larger sample sizes are recommended to validate these findings and evaluate potential side effects or complications associated with dexmedetomidine in diverse populations.

Conclusion

This randomized controlled trial demonstrated that dexmedetomidine is a superior adjuvant to bupivacaine compared to tramadol for spinal anesthesia in infra-umbilical surgeries. Dexmedetomidine significantly shortened the onset time of the sensory block, prolonged the duration of analgesia, and delayed the need for rescue analgesia with lower pain scores intraoperatively and postoperatively. These findings highlight the clinical utility of dexmedetomidine in enhancing the efficacy of spinal anesthesia, making it a preferred choice for prolonged surgical procedures. However, further large-scale studies are recommended to confirm these results and ensure safety across diverse populations.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.

Approved by the department concerned. (IRBEC-CSDU-12/20)

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared an absence of conflict of interest.

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