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Comparison of the Effectiveness of Tramadol and Dexmedetomidine as Adjuvants in Spinal Anesthesia for Prolonging Postoperative Analgesia in Patients Undergoing Hysterectomy (TAH & Vaginal Hysterectomy)

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ABSTRACT

TAH is a major procedure with significant postoperative pain, managed through various anesthetic techniques. Intrathecal dexmedetomidine offers consistent, opioid-sparing analgesia, whereas tramadol provides analgesic and anti-shivering effects but shows more variable and less established efficacy. **Objectives:** To evaluate the effectiveness of dexmedetomidine and tramadol in spinal anesthesia for extending postoperative analgesia in hysterectomy. **Methods:** A quasi-experimental study was conducted at M. Islam Medical and Dental College Teaching Hospital on two equal groups of 110 elective hysterectomy patients who were randomly assigned. Group T was given tramadol, and Group D was given dexmedetomidine. Clinical and demographic baselines were documented. Time to first rescue analgesia and total rescue analgesic intake were the main results. Patient satisfaction, incidence of adverse effects, and postoperative pain intensity were evaluated at multiple intervals. Data analysis was conducted by SPSS version 26.0 with statistical significance set at $p<0.05$. **Results:** The dexmedetomidine group's patients consumed less rescue analgesic overall ($p<0.001$) and had a considerably longer duration to initial rescue analgesia ($p<0.001$) than the tramadol group. Additionally, the dexmedetomidine group had considerably higher patient satisfaction ($p=0.002$). At every time point, the dexmedetomidine group's VAS pain scores were consistently lower ($p<0.001$). There was no discernible difference in the frequency of side effects between the groups. **Conclusions:** Dexmedetomidine resulted in improved postoperative pain control and greater patient satisfaction and reduced analgesic consumption compared to tramadol, with a comparable safety profile. It represents an effective option for multimodal postoperative pain management following hysterectomy.

INTRODUCTION

A total abdominal hysterectomy (TAH) is a large-scale operation that is associated with significant risk of postoperative pain and associated morbidity. Different methods of anesthesia have been used in the management of pain in TAH, including general, epidural, spinal anesthesia, abdominal blocks, and local infiltration. It is amazing that despite these alternatives, postoperative pain is still a major issue: the proportion of women reporting moderate to severe pain in the first 24 hours is as high [1]. Such a significant pain burden is evident in the patterns of opioid use, as women having a benign hysterectomy receive an average of 143.5 morphine

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milligram equivalents (MME) of opioids as part of the perioperative process, and 83% of them are given opioids at the time of hysterectomy [2]. A large systematic review similarly found that patients undergoing abdominal hysterectomy consume approximately 108 MME (equivalent to about 14.5 tablets of 5-mg oxycodone) in the first 14 days post-discharge, compared to only around 35 MME after vaginal hysterectomy. Persistent opioid use, although relatively rare, affects around 5% of patients following benign hysterectomy procedures [3]. These figures collectively highlight the substantial analgesic demands and opioid exposure after hysterectomy, reinforcing the imperative for strategies that effectively prolong analgesia while reducing opioid requirements. Both vaginal and TAH frequently result in moderate-to-severe nociceptive pain during the first 24 hours, which increases the need for opioids, delays movement, and lengthens hospital stays [4]. Subarachnoid anesthesia is a common choice in lower abdominal and gynecologic procedures, and it is frequently supplemented with intrathecal adjuvants to extend analgesia without causing systemic opioid effects. One of the most effective adjuvants is dexmedetomidine, which is a highly selective 2-agonist that consistently prolongs sensory and motor block and deferrals the necessity of rescue analgesia [5, 6]. Nevertheless, dexmedetomidine can lead to dose-dependent bradycardia, hypotension, and sedation, with the most common dosage range now set on microgram levels [7-9]. Tramadol is a non-canonical opioid, which has analgesic effects because of low-affinity μ stimulation and reuptake inhibition of norepinephrine and serotonin. Doses up to approximately 20mg have demonstrated the potential of prolonging sensory block and counteracting shivering in infra-umbilical surgeries when administered intrathecally. Evidence is, however, limited and harsh against that of dexmedetomidine, with a significant number of studies investigating tramadol using alternative routes. There is also limited experience on the intrathecal use of tramadol, with most studies either using different categories of surgery or assessing anti-shivering effects, but not the analgesic effect duration [10, 11]. Higher doses of tramadol have been associated with side effects like nausea, vomiting, and risk of seizures, which restrict the widespread intrathecal use of tramadol. The relevance of this gap is that analgesic requirements and hemodynamic reactions differ across procedures, and generalization across specialties is invalid [12]. Postoperative pain management is a critical issue related to the hysterectomy of women because insufficient analgesia may slow down the process of mobilization, extend the time spent in the hospital, increase the level of opioid consumption, and lead to decreased patient satisfaction. Dexmedetomidine is reported to lengthen sensory and motor blockage in the presence of opioid-sparing effects, but with a risk of sedation and hemodynamic alterations. Tramadol has an intrathecal analgesic and anti-shivering effect, although the effect is less reliable.

This study aimed to determine the efficacy of intrathecal tramadol and dexmedetomidine when used as adjuvants to the spinal anesthesia in patients undergoing hysterectomy.

METHODS

This quasi-experimental research involved a comparison of the effectiveness of intrathecal tramadol and dexmedetomidine in extending postoperative analgesia in women who underwent a hysterectomy. It was done in the Department of Anesthesiology at the M. Islam Medical and Dental College Teaching Hospital during a period of more than six months, from 1 February 2025 to 31 July 2025. The Institutional Research and Ethics Committee was consulted and provided ethical approval (Approval No: RC/020/2025), which was in compliance with the Declaration of Helsinki. The open-ended Open Epi two means formula was used to calculate the sample size (180 minutes (SD) = pooled and 101 minutes = mean difference based on previous literature) and used 0.05 and 80 percent as the α and power, respectively. This provided 50 patients in each group; a 10% rate of attrition brought up the final sample of 110 patients (55 patients each) [10, 13]. Written informed consent was taken. Non-probability consecutive sampling was used to recruit participants. The inclusion criteria were a group of women between the ages of 35 and 65 years who were to undergo an elective TAH or vaginal hysterectomy under spinal anesthesia. The exclusion criteria were severe cardiovascular disease, neurological conditions, long-term opioid or sedative use, severe organ dysfunction, pregnancy, and unsuccessful spinal anesthesia. Pre- anesthetic and routine intraoperative assessment were done on all the patients. The spinal anesthesia was administered at L3-L4 or at L4-L5 with the 25G Quincke needle. Assigning patients to one of two groups was done according to the adjuvant to be used: Group D was put on 3 mL of 0.5% hyperbaric bupivacaine and 5 μg dexmedetomidine, and Group T was put on 3 mL of 0.5% hyperbaric bupivacaine and 20mg tramadol. The intraoperative and postoperative hemodynamic parameters have been measured at specific times every five minutes and at fixed times. The main outcome was time to first rescue analgesia, and this is a ratio of the time between intrathecal injection and VAS pain score 4 or greater [14, 15]. The secondary outcomes were VAS scores at 2, 4, 6, 12, and 24 hours, total rescue analgesic consumption at 24 hours, adverse effects (hypotension, bradycardia, nausea, vomiting, pruritus, shivering,

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sedation, urinary retention), and patient satisfaction at 24 hours. IV diclofenac and /or tramadol were used as rescue analgesia. The structured proforma was used to gather the data. SPSS version 26.0 was used to assess the data. The Shapiro-Wilk test was used to test the normalcy of continuous variables. Continuous data were presented as mean, SD, or median (IQR), whereas categorical variables were presented in the form of frequencies and percentages. These independent variables were age, ASA status, type of hysterectomy, baseline hemodynamics, and type of intrathecal adjuvant. The independent samples t-test was applied to compare groups that had normally distributed variables, and the Mann-Whitney U test was applied to compare non-normally distributed variables. The p-value of less than 0.05 was statistically significant.

RESULTS

Participants in both groups were primarily in their mid-forties, and the mean age was comparable. Additionally, there was no discernible variation in the average Body Mass Index (BMI) between the groups. More than half of the patients in both groups had ASA I physical status (56.4% in the Dexmedetomidine group and 60.0% in the Tramadol group), with the remaining patients in both groups having ASA II physical status (43.6% and 40.0%, respectively) (Table 1).

Table 1: Clinical and Demographic Features of Patients

Variables	Dexmedetomidine (n=55)	Tramadol (n=55)	p-value
Age (Years)			
Mean ± SD	46.8 ± 7.2	47.5 ± 6.8	0.623*
BMI (kg/m²)			
Mean ± SD	26.9 ± 3.4	27.1 ± 3.6	0.789*
ASA Physical Status, n (%)			
ASA I	31 (56.4%)	33 (60.0%)	0.712**
ASA II	24 (43.6%)	22 (40.0%)	
Type of Hysterectomy, n (%)			
TAH	29 (52.7%)	28 (50.9%)	0.846**
Vaginal	26 (47.3%)	27 (49.1%)	
Baseline MAP (mmHg),			
Mean ± SD	92.5 ± 8.1	91.7 ± 7.9	0.645*
Baseline HR (beats/min)			
Mean ± SD	78.2 ± 6.9	77.6 ± 7.1	0.721*

Mann-Whitney U test and Chi-square test **p-value<0.001, *p-value<0.05

Strong statistical significance (<0.001) was indicated by the p-value, which showed that the Dexmedetomidine group had a significantly longer time to first request rescue analgesia. Similarly, the Dexmedetomidine group consumed considerably less rescue analgesics overall within the first 24 hours than the Tramadol group (p-value <0.001). Dexmedetomidine recipients had higher patient satisfaction levels on a 24-hour Likert scale; this difference was statistically significant (p=0.002) (Table 2).

Table 2: Comparison of Outcomes of the Study Participants (n=110)

Outcomes	Dex-medetomidine (n=55)	Tramadol (n=55)	p-value
Time to First Rescue Analgesia (min)	420.6 ± 50.2	310.4 ± 55.3	<0.001*[a]
Total Rescue Analgesic Consumption (mg)	74.8 ± 14.6	119.6 ± 19.8	<0.001*[a]
Patient Satisfaction (Likert 1-5), Median (IQR)	5 (4-5)	4 (3-4)	0.002b**

[a]Independent sample t test & b Mann Whitney test **p-value<0.001, *p-value<0.05

When the Visual Analogue Scale (VAS) was used to compare the two groups' postoperative pain severity, the Dexmedetomidine group consistently scored lower at all time periods. Patients who received Dexmedetomidine reported considerably lower levels of pain at 2, 4, 6, 12, and 24 hours than those who received Tramadol; all comparisons showed p-values <0.001. These findings suggest that Dexmedetomidine maintained greater analgesic efficacy over the first 24 hours after hysterectomy, in addition to delaying the onset of substantial postoperative pain (Table 3).

Table 3: VAS Pain Scores at Different Time Points Reported by the Study Participants (n=110)

Time Point (Hours)	Dexmedetomidine VAS, Mean ± SD	Tramadol VAS, Mean ± SD	p-value
2 Hours	2.1 ± 0.5	3.2 ± 0.6	<0.001*[a]
4 Hours	2.4 ± 0.5	3.5 ± 0.6	<0.001*[a]
6 Hours	2.7 ± 0.6	3.8 ± 0.7	<0.001*[a]
12 Hours	3.1 ± 0.5	4.2 ± 0.6	<0.001*[a]
24 Hours	3.6 ± 0.6	4.6 ± 0.7	<0.001*[a]

[a]Independent sample t test **p-value<0.001, *p-value<0.05

There were no statistically significant variations in the incidence of negative effects, which were spread evenly across the two groups. Bradycardia was seen in 4 (8%) of patients in the Dexmedetomidine group versus 1 (3%) in the Tramadol group (p=0.365), and hypotension was seen in 3 (6%) of patients versus 2 (4%) in the Tramadol group (p=0.651). Compared to 8 (15%) of patients in the Tramadol group, 5 (10%) of patients receiving Dexmedetomidine had nausea and vomiting (p=0.424). Compared to 1 (2%) and 2 (5%) of patients in the Dexmedetomidine group, pruritus and shivering were more common in Tramadol users, occurring in 4 (8%) and 6 (12%) of patients, respectively (p=0.173 and p=0.145). Rarely, urinary retention was observed in 2 (3%) of Tramadol patients and 2 (4%) of Dexmedetomidine patients (p=0.756). In contrast to 3 (5%) in the Tramadol group, 5 (9%) of those on Dexmedetomidine experienced sedation (p=0.467) (Table 4).

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Table 4: Incidence of Adverse Effects

Adverse Effects	Dexmedetomidine (n=55), n (%)	Tramadol (n=55), n (%)	p-value
Hypotension	3 (6%)	2 (4%)	0.651
Bradycardia	4 (8%)	1 (2%)	0.365
Nausea/Vomiting	5 (10%)	8 (15%)	0.424
Pruritus	1 (2%)	4 (7%)	0.173
Shivering	2 (5%)	6 (12%)	0.145
Urinary Retention	2 (4%)	2 (3%)	0.756
Sedation	5 (9%)	3 (5%)	0.467

Fisher's Exact test, *p-value<0.05

DISCUSSION

In this prospective comparative cohort of 110 hysterectomy patients, intrathecal dexmedetomidine produced a clinically and statistically significant prolongation of postoperative analgesia, reduced 24-hour rescue analgesic consumption, and yielded lower VAS pain scores across all time points compared with intrathecal tramadol. These findings are consistent with a growing body of literature demonstrating that intrathecal dexmedetomidine reliably prolongs sensory blockade and time to first analgesic request when added to local anesthetics. A comprehensive systematic review and meta-analysis by Paramasivan et al. reported significant prolongation of postoperative analgesia with intrathecal dexmedetomidine versus placebo across diverse surgeries, and cautioned that dose selection must balance efficacy against hemodynamic effects [7]. Similarly, Kumar *et al.* pooled randomized data and concluded that dexmedetomidine added to bupivacaine increases the duration of sensory and motor block and reduces early postoperative opioid requirements [9]. Our observed magnitude of benefit (≈110 minutes longer median time to first rescue analgesia and substantially lower 24-hour analgesic consumption) sits comfortably within the effect sizes reported for dexmedetomidine in these meta-analyses, supporting the external validity of our results. Dose-response and route-specific work help explain why dexmedetomidine produced consistent analgesic benefits in our cohort. Several dose-finding and randomized trials between 2020–2023 demonstrated that small intrathecal microgram doses (commonly 3–10 µg) prolong analgesia in a dose-dependent manner without major neurotoxicity signals when administered with appropriate local anesthetic doses. Bao *et al.* and Zhang *et al.* reported faster onset and longer duration of block with low-microgram intrathecal dexmedetomidine added to ropivacaine or bupivacaine, findings that align with the improved early and late VAS scores we observed [8, 16]. A study by Mo *et al.* further refined the ED50 for intrathecal dexmedetomidine in obstetric spinal anesthesia, reinforcing that small, precise doses maximize analgesia while limiting bradycardia/hypotension risk, a consideration reflected in our low but measurable rates of bradycardia and hypotension [17]. In contrast, intrathecal tramadol's data in the literature were more heterogeneous. Several recent randomized and comparative studies continue to show that tramadol can prolong analgesia when added to spinal bupivacaine and provides anti-shivering benefits, but the magnitude of analgesic extension is generally smaller and less consistent than that reported with dexmedetomidine. The trials assessing intrathecal or perioperative tramadol in abdominal and urological procedures reported reductions in early pain and anti-shivering effects, but variable effects on overall 24-hour opioid-sparing. [10, 18]. Current findings showed that tramadol produced shorter analgesic duration, higher rescue consumption, and higher VAS than dexmedetomidine, therefore align with this pattern of more modest and variable tramadol efficacy. A recent comparative study in a mixed surgical population reported superior block characteristics and longer analgesia with dexmedetomidine versus tramadol and other adjuvants, mirroring our results in the hysterectomy cohort [19]. Mechanistically, these differences are plausible: Dexmedetomidine produces spinal analgesia by α2-adrenergic receptor-mediated inhibition of nociceptive neurotransmission in the dorsal horn and by reducing C-fiber neurotransmitter release, whereas tramadol's multimodal action may provide analgesia but with less potent and shorter intrathecal effect at commonly used doses. This pharmacologic distinction likely explains both the longer duration and lower VAS in the dexmedetomidine arm of present study [20]. Current results are consistent with previous data demonstrating the better analgesic profile of dexmedetomidine, but these studies are difficult to compare due to the heterogeneity of surgical populations, the use of different doses, and even differences in the definition of outcomes. Despite these limitations, our data specific to hysterectomy supports the use of intrathecal dexmedetomidine as an adjuvant and highlights the need for procedure-specific, standardized trials to perfect dosage and safety.

CONCLUSIONS

In patients having a hysterectomy, this study showed that dexmedetomidine offers better postoperative analgesia than tramadol. This is demonstrated by a significantly longer time to first rescue analgesia, lower overall analgesic consumption, lower pain scores at all time intervals observed, and higher patient satisfaction. Crucially, the safety profiles of the two medications were similar, with no statistically significant variation in the frequency of side events.

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Methodology: HFA, MB, SA
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All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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