Original Research

COMPARISON OF PROPHYLACTIC USE OF INTRAVENOUS DEXMEDETOMIDINE AND MAGNESIUM SULPHATE FOR PREVENTION OF SHIVERING DURING TRANSURETHRAL RESECTION OF THE PROSTATE (TURP) UNDER SPINAL ANAESTHESIA: A PROSPECTIVE RANDOMIZED DOUBLE-BLIND CONTROLLED STUDY

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ABSTRACT

Background: Transurethral resection of the prostate (TURP) is routinely performed under spinal anesthesia. The profound sympathetic nerve blockade, coupled with continuous room-temperature irrigation fluid, acts as a massive thermal drain, rapidly stripping the body of thermal energy and leading to a remarkably high incidence of post-spinal shivering.

Aims and Objectives: This study aimed to compare the prophylactic efficacy of intravenous dexmedetomidine and intravenous magnesium sulfate against a normal saline control in preventing post-spinal anaesthesia shivering and to evaluate hemodynamic stability, sedation, postoperative analgesia, and complication profiles.

Materials and Methods: This prospective, randomized, double-blind controlled trial was conducted in 90 male patients with ASA Grade I or II who were scheduled for elective TURP under subarachnoid block. Patients were randomized into three groups of 30 patients each. Group C received 100 ml of 0.9% Normal Saline; Group D received 0.5 µg/kg of dexmedetomidine in 100 ml of normal saline, and 30 mg/kg of magnesium sulfate in 100 ml of normal saline. All study drugs were administered intravenously over 10 min before the subarachnoid block.

Results: The demographic and surgical profiles were statistically comparable across all groups. Dexmedetomidine (Group D) and magnesium sulfate (Group M) demonstrated superior prophylactic efficacy against shivering compared with the control group, with 93.3% of patients in Group D and 83.3% in Group M experiencing Grade 0 (no shivering). Group D provided profound conscious sedation (mean Ramsay Score 3.60 ± 0.67) and the most significant prolongation of postoperative analgesia (VAS 13.07 ± 4.05 at 4 hours, $p<0.001$). However, Group D exhibited a higher incidence of hypotension (36.7%) and bradycardia (10.0%), whereas Group M maintained superior chronotropic stability.

Conclusion: Dexmedetomidine and magnesium sulfate are highly effective in preventing shivering associated with spinal anesthesia in patients with TURP. Dexmetatomidine offers superior postoperative analgesia and excellent cooperative sedation, whereas magnesium sulfate provides potent anti-shivering action while maintaining superior hemodynamic stability.

Keywords: Dexmedetomidine, Magnesium Sulfate, Spinal Anesthesia, Shivering, TURP.

www.ajmrhs.com
eISSN: 2583-7761

Date of Received: 13-03-2026
Date Acceptance: 20-03-2026
Date of Publication: 22-04-2026
doi.org/10.65605/ajmrhs.2026.v04.i01.pp1278-1285

INTRODUCTION

Thermoregulation constitutes a fundamental physiological mechanism in human homeostasis, maintaining core body temperature within a narrow optimal range. This delicate balance faces significant challenges during surgical procedures, particularly with neuraxial anesthesia, with reported

incidence rates of hypothermia and shivering ranging from 50% to 90% in various populations.[1,2]Shivering, characterized by involuntary oscillatory muscle movements, emerges as a frequent and clinically significant complication.[3]

Transurethral resection of the prostate remains the most widely used surgical intervention for benign prostatic hyperplasia. It is routinely and preferentially performed under central neuraxial blockade.[1] While spinal anesthesia provides excellent surgical conditions, it inherently causes a profound sympathetic nerve blockade, resulting in massive peripheral vasodilation and abolishing the body's primary physiological defense against heat loss.[4,5] This physiological heat loss is drastically accelerated during TURP due to the continuous absorption of room-temperature irrigation fluids directly into the exposed prostatic venous sinuses.[1,6]

Shivering is a highly metabolic skeletal muscle activity that dramatically increases oxygen consumption (by up to 400%), carbon dioxide production, and cardiac output requirements.[7,8] In the elderly, frail TURP demographic, this sudden spike in myocardial oxygen demand can precipitate ischemia, arrhythmias, or myocardial infarction[6]. The ideal anti-shivering agent should effectively prevent the thermoregulatory threshold from triggering the shivering reflex without causing significant haemodynamic depression, respiratory compromise, or postoperative nausea and vomiting (PONV)[9]. Dexmedetomidine, a highly selective, centrally acting α2-adrenergic receptor agonist, lowers the shivering threshold while simultaneously providing titratable sedation and opioid-sparing analgesia.[10,11]Magnesium Sulfate acts as a non-competitive antagonist of the N-methyl-D-aspartate (NMDA) receptor, lowering the shivering threshold by decreasing central nervous system excitability and inducing mild peripheral vasodilation [12,13].

Aims and Objectives

1. To compare the prophylactic efficacy of intravenous dexmedetomidine 0.5 mcg/kg body weight and intravenous magnesium sulfate 30m mg/kg body weight against a normal saline control in preventing post-spinal anesthesia shivering.
2. To evaluate the haemodynamic stability and respiratory safety of the study drugs.
3. To compare the intraoperative sedation depth using the Ramsay Sedation Score.
4. To evaluate postoperative analgesics using visual analog scale (VAS) scores.
5. To observe the comprehensive adverse event profiles associated with these pharmacological interventions.

MATERIALS AND METHODS

A prospective, randomized, double-blind, controlled clinical trial was conducted in the Department of anesthesiology, J.A. Group of Hospitals and G.R. Medical College, Gwalior. Following institutional ethical committee approval and informed written consent, 90 male patients presenting for elective TURP under subarachnoid block, belonging to American Society of Anesthesiologists (ASA) Physical Status Grade I or II, were enrolled. Patients who refused or were unable to provide informed consent, had known hypersensitivity to the study drugs (dexmedetomidine, magnesium sulfate, or local anesthetics), and had significant coexisting diseases including:Severe renal disease (creatinine > 2.0 mg/dL), severe hepatic disease (Child-Pugh class B or C), thyroid disorders, Parkinson's disease, dysautonomia, Raynaud's syndrome, significant cardiopulmonary disease, cerebrovascular disease, contraindications to regional anesthesia (local infection, bleeding disorders), and BMI > 32 kg/m were excluded from the study.

Patients were randomized into three groups of 30 patients each via a computer-generated sequence:

1. **Group C (Control):** Received 100 ml of 0.9% normal saline intravenously over 10 minutes.
2. **Group D (Dexmedetomidine):** Received 0.5 µg/kg of Dexmedetomidine diluted in 100 ml of normal saline intravenously over 10 min.
3. **Group M (Magnesium Sulfate):** Received 30 mg/kg of magnesium sulfate diluted in 100 ml of normal saline intravenously over 10 minutes.

All infusions were administered intravenously just before spinal anesthesia administration. All patients underwent detailed preoperative assessment, including history, physical examination, and routine investigations. Written informed consent was obtained after the procedure and study protocol were explained. The operating room temperature maintained at 21-22°C. All irrigation and intravenous fluids were at room temperature without warming. [14] Patients were covered with single-layer surgical drapes over their chest, thighs, and calves during surgery. One cotton blanket was used to cover the entire body postoperatively. No additional heating devices were used. Standard ASA monitors (ECG, non-invasive blood pressure, and pulse oximetry) were applied. Intravenous access was secured with an 18G cannula. Each patient received 10 ml/kg/h of Ringer's lactate solution over half an hour, followed by maintenance at 2 ml/kg/h. Study drug infusion administered over 10 min before spinal anesthesia. Spinal anesthesia was performed

in the sitting position at L3-4 or L4-5 interspace under strict aseptic conditions 3 ml of 0.5% hyperbaric bupivacaine was injected using a 23-gauge spinal needle. Supplemental oxygen was administered via face mask at 4 L/min throughout the procedure.

Intraoperative hemodynamics (pulse rate, systolic, diastolic, and mean arterial blood pressures) were recorded at baseline and at 5, 10, 15, 20, 25, 30, 45, 60, and 120 min. Shivering was assessed using the Crossley and Mahajan Scale.[15] Intraoperative sedation was graded using the Ramsay Sedation Score. Postoperative pain was evaluated at 1, 2, 4, 8, 16, and 24 h using the VAS. Adverse events, such as nausea, vomiting, hypotension, and bradycardia, were meticulously documented. The core temperature was measured using a tympanic thermometer. Hypothermia defined as core temperature < 36.5°C. Hypotension was defined as if MAP < 65 mmHg or > 20% decrease from baseline and Bradycardia if HR < 50 bpm. Adverse events, such as bradycardia, hypotension, and nausea or vomiting, were treated with 0.6 mg atropine injection, mephentramine injection, or i.v. Fluids from 6 ml/kg/h to 10 ml/kg/h if required, and 4 mg IV ondansetron injection, as per the institutional protocol.

Statical Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences software (latest version). Continuous variables were presented as mean ± standard deviation and compared using one-way analysis of variance followed by post hoc tests. Categorical variables were expressed as frequencies and percentages and analyzed using the chi-square test or Fisher's exact test, as appropriate. A p-value < 0.05 was considered statistically significant. All analyses were performed on an intention-to-treat basis.

RESULTS

Demographic and Baseline Characteristics: Age, height, weight, body mass index (BMI), and American Society of Anesthesiologists (ASA) physical status grades were perfectly comparable across all three groups with no statistically significant differences ($p > 0.05$) (Table 1). The mean duration of surgery and anesthesia were also statistically identical across the cohorts, confirming that the cold irrigation fluid uniformly imposed a profound thermal drain

Table 1: Demographic and Baseline Characteristics of the Study Participants

Parameter	Group C (Control) Mean ± SD	Group D (Dexmedetomidine) Mean ± SD	Group M ($MgSO_4$) Mean ± SD	P-Value	Sig.
Age (years)	66.48 ± 7.20	66.37 ± 7.55	66.80 ± 7.21	0.972	NS
Weight (kg)	65.86 ± 6.85	66.20 ± 6.59	66.00 ± 6.81	0.981	NS
BMI (kg/m^2)	25.25 ± 3.39	25.52 ± 3.24	25.04 ± 3.56	0.864	NS
ASA Grade I, n (%)	10 (33.3%)	8 (26.7%)	12 (40.0%)	0.549	NS
ASA Grade II, n (%)	20 (66.7%)	22 (73.3%)	18 (60.0%)	0.549	NS

Hemodynamic Parameters (Pulse Rate, MAP)

Baseline heart rates were uniform in all groups. However, Group D exhibited profound, sustained, and progressive bradycardia, dropping sharply to a lowest of 55.8 ± 5.9 beats/min at the 25-minute mark ($p < 0.001$). Conversely, Groups C and M maintained highly stable, non-fluctuating mean HRs above 71 beats/min throughout the intraoperative period.

The baseline mean arterial pressure was similar across the groups. MAP decreased significantly at 10 min, with an early, more marked drop in the magnesium group and a later, more sustained reduction in the dexmetatomidine group. These intergroup differences were statistically significant up to 60 min, but by 2 h postoperatively, MAP had largely normalized in all groups without significant differences.

A statistically significant difference was observed in the three groups throughout the duration of surgery when the mean core temperatures (Fig. 1) were compared.

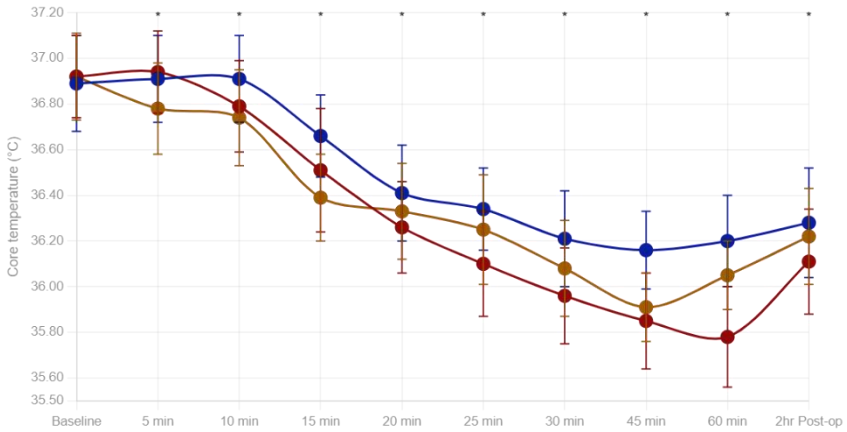

Fig. 1 Mean Core Temperature (°C) At Different Intervals of Time Intergroup Comparison

Intraoperative Shivering: Dexmetatomidine and Magnesium Sulfate demonstrated superior prophylactic efficacy against shivering compared with the control group (Table 2). In Group C, 53.3% of the patients experienced clinical shivering, with 10.0% experiencing violent Grade 4 shivering. In contrastMoreover, 93.3% of patients in group D and 83.3% in group M experienced Grade 0 (no shivering). Grade 1 shivering was experienced by 13.3% in controls, 6.7% in group D, and 13.3% in group M. Grade 2 was seen in 33.3% of patients in controls, 3.3% in group M, and 0 in group D. Grades 3 and 4 were observed in 23.3% of patients only in controls. Both study groups completely abolished grade 4 shivering.

Table 2. Distribution of Post-Spinal Anesthesia Shivering Grade

Shivering Grade	Group C (Control) n (%)	Group D (dexmedetomidine) n (%)	Group M (MgSO4) n (%)	Total N (%)
Grade 0	9 (30.0%)	28 (93.3%)	25(83.3%)	62(68.9%)
Grade 1	4 (13.3%)	2 (6.7%)	4 (13.3%)	10(11.1%)
Grade 2	10 (33.3%)	0(0.0%)	1 (3.3%)	11(12.2%)
Grade 3	4(13.3%)	0(0.0%)	0 (0.0%)	4(4.4%)
Grade 4	3 (10.0%)	0(0.0%)	0 (0.0%)	3(3.3%)
Mean ±SD	1.60 ± 1.33	0.07 ± 0.25	0.20 ± 0.48	---
Kruskal-Wallis H = 36.988	p < 0.001	C vs. D: p<0.001	C vs. M: p<0.001	D vs M: p = 0.681

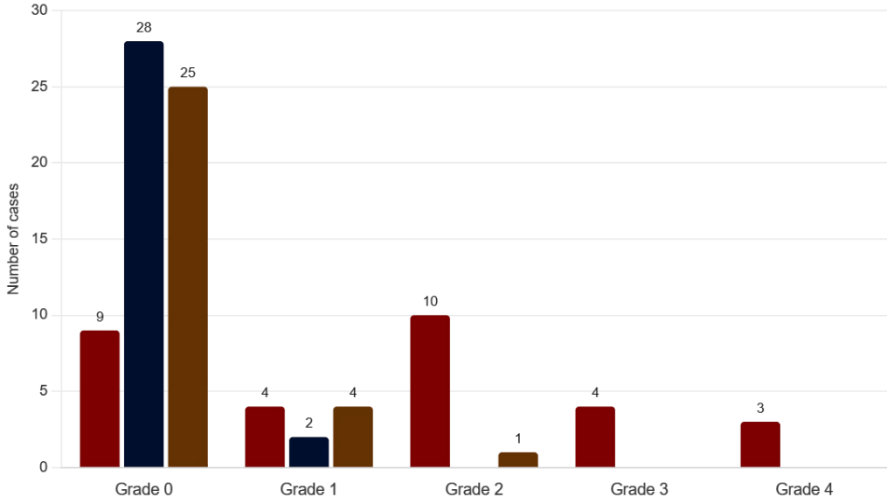

Fig.2. 1 Distribution of Post-Spinal Anesthesia Shivering Grade

Intraoperative Sedation A highly significant difference in sedation profiles (Table 3) was observed among the groups (H = 51.001, p < 0.001). Dexmetatomidine provided significantly deeper, conscious sedation (Mean ± SD: 3.60 ± 0.67). Group M (2.20 ± 0.41) behaved similarly to the control group (2.47 ± 0.51), acting primarily as an analgesic rather than a hypnotic.

Table 3: Distribution of Intraoperative Ramsay Sedation Scores

Sedation Score	Group C (Control) N (%)	Group D (dexmedetomidine) N (%)	Group M (Mgso4) N (%)	Total (N %)
Score 1	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Score 2	16 (53.3%)	0 (0.0%)	24 (80.0%)	40 (44.4%)
Score 3	14 (46.7%)	15 (50.0%)	6 (20.0%)	35 (38.9%)
Score 4	0 (0.0%)	12 (40.0%)	0 (0.0%)	12 (13.3%)
Score 5	0 (0.0%)	3 (10.0%)	0 (0.0%)	3 (3.3%)
Mean ± SD	2.47 ± 0.51	3.60 ± 0.67	2.20 ± 0.41	---
H = 51.001	p < 0.001	C vs. D: p<0.001	C vs. M: p = 0.092 (NS)	D vs. M: p<0.001

Postoperative Analgesia: At 1 h postoperatively, pain scores were low and statically comparable across all three groups (Table 4). From 2 hours onward, significant intergroup differences emerged (p<0.001). Dexmedetomidine consistently produced the lowest VAS scores throughout, peaks at 4 h. At the 4-h postoperative mark, corresponding with the regression of the spinal block, Group C experienced a significant spike in pain (VAS 64.80 ± 8.41). Group M provided moderate relief (VAS 42.13 ± 7.13). Group D maintained profound, statistically significant analgesia (VAS 13.07 ± 4.05) and continued to provide the lowest pain scores throughout the 24-hour evaluation period (p < 0.001).

Table 4: Comparison of Postoperative VAS Pain Scores

Time Point	Group C (Control) Mean ± SD	Group D (Dexmedetomidine) Mean ± SD	Group M (MgSO4) Mean ± SD	P-Value	Sig.
1 Hour	2.00 ± 1.44	2.33 ± 1.52	2.17 ± 1.49	0.653	NS
2 Hours	19.70 ± 5.84	5.47 ± 2.87	9.53 ± 2.62	<0.001	S
4 Hours	64.80 ± 8.41	13.07 ± 4.05	42.13 ± 7.13	<0.001	S
8 Hours	32.60 ± 4.95	23.93 ± 3.85	34.93 ± 6.97	<0.001	S
16 Hours	23.73 ± 4.92	18.13 ± 3.40	20.60 ± 4.52	<0.001	S
24 Hours	20.00 ± 5.43	14.70 ± 3.65	18.17 ± 5.13	<0.001	S

Complication Profile: Hypotension was observed in 36.7% of Group D and 30.0% of Group M, compared with 13.3% in Group C. Bradycardia was exclusively highest in the dexmedetomidine cohort (10.0%). Nausea occurred in 13.3%, 6.7%, and 3.3% of the patients in Groups C, M, and D, respectively. No vomiting occurred in any group (p = 0.259).

DISCUSSION

The current study confirmed the high incidence of post-spinal shivering in the unmedicated TURP population, which was directly driven by the severe thermal dissipation of continuous irrigation. [1]
Dexmedetomidine caused a profound and sustained reduction in heart rate and blood pressure dynamics. This chronotropic depression is the pharmacological hallmark of its central α2-adrenergic sympatholytic action, unopposed vagal dominance resulting in decreased heart rate and MAP.[16] These findings strongly align with those of Abdel-Fattah et al.[11] and Sharma et al.[17], who reported significant bradycardia exclusively with dexmedetomidine.
The precise pathophysiology of shivering under regional anesthesia remains unclear. Proposed mechanisms include disruption of central thermoregulatory control, sympathetic blokadge, vasodilation below the block level, and increased heat loss to the environment [4,5].Spinal anaesthesia causes a core-to-peripheral heat shift because the local anesthetic in the subarachnoid space blocks spinal nerve roots. This interruption stops temperature-sensing afferent impulses from the lower body, preventing the brain from accurately regulating core heat[18] resulting in a decrease in core temperature. Our results coincide with the study done by Ibrahim et al.[8] Our findings are in similar with Babaei et al [13] who observed a decreasing trend in the mean core temperature in the

dexmedetomidine group, where the lowest was 35.80-36.20°C, compared to the magnesium sulfate group, where the minimum core temperature was 36.00-36.40 °C.

The primary outcome evaluation demonstrated that both agents possess potent anti-shivering properties. Both dexmedetomidine and magnesium sulfate completely abolished violent grade 3 and 4 shivering and substantially reduced the overall incidence of shivering compared to controls C (30.0%), D (93.3%), and M (83.3%). This is corroborated by Omar MM et al. [12], whose analysis confirmed that the difference between the dexmedetomidine and magnesium sulfate groups was not statistically significant. Usta et al.[19] studied the prophylactic effects of IV dexmetatomidine on shivering. The authors observed that dexmedetomidine infusion significantly decreased the incidence and severity of shivering. Three patients (10%) in group D and 17 patients (56.7%) in group C experienced shivering ($p = 0.001$). These results are similar to the current study.These results agree with those of Abdel-Fattah AM et al[11]. Our study is in accordance with the comprehensive meta-analysis conducted by Wang J et al [9]. Similar findings have also been reported by Ameta et al.[20], Venkatraman et al.[21], Verma et al.[22], Prasad et al.[23], Sachidananda et al.[27] and Singla et al.[24].

Achieving optimal intraoperative sedation during regional anaesthesia is crucial to alleviating patient anxiety and ensuring surgical compliance. Dexmetatomidine provided unparalleled hypnotic efficacy, achieving a significantly deeper mean Ramsay sedation score (3.60 ± 0.67) compared to magnesium sulfate (2.20 ± 0.41). Magnesium sulfate acted primarily as an analgesic without significant hypnotic effects, allowing patients to remain fully awake. These results are in strict accordance with those of Osama Kasen et al.[18] and Abdel-Fattah et al.[11], who concluded that intravenous dexmedetomidine effectively provides safe, easily arousable sedation alongside its anti-shivering properties.

Evaluation of postoperative analgesia via VAS scores revealed the profound opioid-sparing effect of dexmedetomidine. It provided a remarkably low VAS score at the critical 4-hour mark following block regression. This robust prolongation of analgesia is supported by Sharma et al. [17] and Omar et al.[12], who noted significantly reduced rescue analgesic requirements in patients receiving these specific adjuvants compared with saline controls.Hwang et al.[28] further demonstrated that intravenous magnesium sulfate during spinal anaesthesia significantly improves postoperative analgesia.

The safety profiles confirmed that although dexmedetomidine is associated with higher rates of manageable hypotension and bradycardia, it is highly protective against gastrointestinal side effects, with the lowest incidence of nausea. Kundra et al.[29] and Ramesh K et al.[30] Both patients reported near-zero nausea and vomiting when using dexmedetomidine, confirming its highly favorable gastrointestinal profile.

CONCLUSION

This study concluded that both dexmedetomidine and magnesium sulfate are highly effective in preventing shivering associated with spinal anesthesia in patients with TURP. Dexmetatomidine shows slightly better efficacy in blunting severe shivering, providing superior postoperative analgesia, and excellent cooperative sedation. Magnesium sulfate offers potent anti-shivering action while maintaining superior hemodynamic stability. Both drugs are recommended as prophylactic agents. Dexmetatomidine may be preferred when additional sedation and prolonged analgesia are desired, whereas magnesium sulfate is a highly reliable and cost-effective alternative in patients prone to bradycardia.

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How to cite this article: Dr. Devendra Singh, Dr. Neelima Tandon, Dr. Namrata Jain, Dr. Sardar Bhagat Singh, COMPARISON OF PROPHYLACTIC USE OF INTRAVENOUS DEXMEDETOMIDINE AND MAGNESIUM SULPHATE FOR PREVENTION OF SHIVERING DURING TRANSURETHRAL RESECTION OF THE PROSTATE (TURP) UNDER SPINAL ANAESTHESIA: A PROSPECTIVE RANDOMIZED DOUBLE-BLIND CONTROLLED STUDY, Asian J. Med. Res. Health Sci., 2026; 4 (1):1278-1285.
Source of Support: Nil, Conflicts of Interest: None declared.