

Magnesium Sulfate Versus Dexmedetomidine in Controlled Hypotension During Spine Surgeries

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Abstract

Background: Recent years have seen an unusually large number of patients undergoing posterior spine operations. Studies have recorded blood loss between 1 and 3 liters for posterior spine procedures. Drugs used to control hypertension must meet a set of criteria that include being easy to administer and its effect quickly disappears when administration is ceased. Also have a rapid elimination without toxic metabolites and minimal influence on vital organs and have predictable dose-dependent effects.

Objectives: The aim of this study is comparing the effect of magnesium sulphate and Dexmedetomidine during spine surgeries in decreasing the surgical bleeding and controlling blood pressure.

Patients and methods: There were sixty participants in this randomised prospective research of spine surgery patients. Thirty patients were assigned to Group M, which was given magnesium sulphate. While thirty patients were assigned to Group D, where they were given dexmedetomidine.

Results: Both groups had comparable surgical data, except for the duration of operation, which was significantly shorter in group D (1.92 ± 0.27) than in group M (2.20 ± 0.19) p-value < 0.001 . The Systolic blood pressure (SBP) was statistically significantly higher in group M than group D at induction, A5, A15 and A30 (p-value = 0.001, 0.001, 0.001, 0.006). After 30 minutes of induction (A30), the diastolic blood pressure (DBP) in group M (61.07 ± 3.12 mmHg) was statistically significantly higher than in group D (59.1 ± 2.25 mmHg) p-value = 0.022. In addition the group D was significantly less in blood loss (366 ± 50.1 ml) than in the group M (394.5 ± 35.2 ml) p-value = 0.005.

Conclusion: Dexmedetomidine provides better surgical field, controlled hypotension, and less analgesia than magnesium. But consider a long recovery duration.

Keywords: Spine Surgery; Magnesium Sulphate; Dexmedetomidine; Controlled hypotension.

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Introduction

Maintaining stable hemodynamics, dry operative area, and concerns over patient positioning all present distinct problems for the anesthesiologist during a spine surgery. Blood loss during posterior spine operations has been found to range from 1 to 3 litres across a variety of studies, despite the decreasing morbidity and mortality associated with these procedures (Möller et al., 2000).

The ideal drug for controlled hypotension would have certain properties, such as being simple to be administered, having a rapid onset of action, wearing off quickly once dosing is stopped, being rapidly eliminated without toxic metabolites, having minimal effects on vital organs, and having predictable dose-dependent effects (Degoute et al., 2007).

Magnesium sulphate (MgSO₄) has anti-nociceptive properties because it acts as a non-competitive NMDA receptor antagonist (Clarke et al., 2013).

Magnesium infusion during general anaesthesia has been shown in several clinical studies to decrease the amount of anaesthetic needed and the need for pain medication after surgery (Na et al. 2010). In addition to lowering blood pressure, MgSO₄ prevents norepinephrine from being released by inhibiting N-type Ca⁺⁺ channels in nerve terminals. It can extend the effects of muscle relaxants and cause respiratory depression and paralysis in excessive dosages. (Wu et al., 2015).

Dexmedetomidine is a sedative, anxiolytic, and analgesic because it is a highly selective α_2 adrenoceptor agonist. Central α_2A and imidazoline type 1 receptors are mediated by dexmedetomidine (Gertler et al., 2001). By stimulating these central receptors, the body's response to stress is mitigated, bringing in lower blood pressure and heart rate. It lowers the Minimum Alveolar Concentration (MAC) of volatile anaesthetics and produces

bradycardia, hypotension, sleepiness, and arrhythmias in those who are vulnerable (Bekker et al., 2008).

Dexmedetomidine and magnesium sulphate have been the subject of numerous controlled hypotension investigations (Bayram et al. 2015). To the best of our knowledge, no study comparing these two drugs with each other has been reported in the scientific literature for spine procedures, however they have been compared with other agents in terms of their role in hypotensive anaesthesia (Ghodraty et al., 2014; Nazir et al., 2016).

The aim of this study is comparing the effect of magnesium sulphate and Dexmedetomidine during spine surgeries in decreasing the surgical bleeding and controlling blood pressure. In addition, to compare its effect on postoperative pain.

Patients and methods

Sixty patients performed spine surgery enrolled in this study. Patients were randomly divided into two groups. Thirty patients in (Group M) were given magnesium sulphate, while thirty patients were assigned to (Group D), where they were given dexmedetomidine.

This study was carried out at a Qena University Hospital, Egypt, at the time from January 2020 to June 2022 after obtaining approval from the Ethics Committee of Faculty of Medicine, South Valley University, and written informed consent.

Inclusion criteria

- Spine surgery
- Aged between (18 - 60) years old
- ASA I-II patients.
- GGS 15

Exclusion criteria

- ASA III, IV patients.
- Patients known to be hypertensive.
- Patients with kidney, liver, haematological and neuromuscular diseases, and diabetic neuropathy.
- Age (<18 and > 60) years old

- Patients who have a previous history of allergy to any of the study medicines.
- Patients above 30% overweight.
- Patients receiving calcium channel blockers, non-steroidal anti-inflammatory medications, neuromuscular blockers, and drugs contraindicated for controlled hypotension.

All patients were submitted to the following

- Magnesium sulphate (40 mg/kg loading dosed over 10 minutes followed by an infusion of 10 mg/kg/hr till the end of surgery) was given to patients in group M, while dexmedetomidine (1 g/kg loading dosed over 10 minutes followed by an infusion of 0.2:0.7 mcg/kg/hr till the end of surgery) was given to patients in group D. Both groups' patients were then positioned prone.
- For increases of 20% or more from baseline in either heart rate or mean blood pressure, was treated by increasing depth of anaesthesia by isoflurane end-tidal concentration 0.2% every 4 minutes up to a maximum of 1.3%. If hypertension continued to persist appropriate antihypertensive agents like beta blocker was used. Ephedrine 6 mg intravenously was given if hypotension (SBP 90 mm Hg) manifested. Atropine 0.6 mg bolus was administered to treat bradycardia (HR 50 beats per minute). When hemodynamic variables were beyond the predefined frame, the number of interventions that were necessary were counted.
- The studied drug infusion had been discontinued when the surgeon started skin closure. At the end of surgery, patients had been positioned supine and neuromuscular blockade had been reversed. A neurological assessment had been conducted by the surgeon and he had shifted to the recovery room.

- Patients with an Aldrete score ≥ 9 were transferred to the ward.
- VAS (Visual Analogue Score) was recorded every 4 hours till 24 hours post-operative if VAS is 4 or higher ketorolac 30 mg was given iv with maximum 120 mg/day.

Data collection

- **Hemodynamic variables** (HR, SBP, DBP, MAP), PSao₂, Etco₂, End-tidal inhalational agent concentration was noted during the various stages of the surgery:
 1. Base line.
 2. At induction
 3. After skin incision, (maximal rise within 3 min).
 4. Every 15 min during surgery.
 5. Every 15 min post operative for 1 h, and then every 60 min till 6 h post operative.
- **Recovery from anesthesia**, Intraoperative total fentanyl and antihypertensive use were noted. Recovery characteristics were assessed using the time of extubating and Modified Aldrete Score (0 to 10) at 10 minutes after tracheal extubating.
- **Time to first analgesic rescue in PACU**, the level of postoperative pain was assessed by patient questioning, using a visual analogue scale (VAS) from (0 to 10).
- **Visual Analogue Score**, we assess pain for patients' group as a baseline by (VAS) visual analogue scale which is a valid and reliable measure of chronic pain intensity, as well as acute pain measurement using a ruler.

The score of pain intensity is determined by patients providing a mark between 0-10 with score from 0-4 mild pain, 5-7 moderate pain and 8-10 Severe pain.

Statistical Analysis

All analyses were performed with the IBM SPSS 20.0 software. Continuous variables described by mean \pm standard deviation (Mean \pm SD) where categorical variables were described by number and percent (N, %). Comparison between continuous variables was done by t-test where Chi-square and Mann Whitney U tests were used

to compare categorical variables. A two-tailed $p < 0.05$ was considered statistically significant.

Results

(Table.1) provides a summary of preoperative patient characteristics. There were no statistically significant variations in the baseline demographics and preoperative features of the two groups.

Table 1. Preoperative patients' characteristics

Variable	Group M (n=30)	Group D (n=30)	P-value
Age (years)	45.37 \pm 6.88	45.9 \pm 5.80	0.747
Gender			0.436
Male	18 (60%)	15 (50%)	
Female	12 (40%)	15 (50%)	
BMI (kg/m ²)	28.53 \pm 1.63	28.8 \pm 1.49	0.512
Spine surgery			0.417
• Cervical	9 (30%)	12 (40%)	
• Lumbar	21 (70%)	18 (60%)	

Continuous data are presented as (mean \pm SD), while categorical variables are presented as a percentage, BMI; Body Mass Index, * Significant.

Both groups had comparable surgical data, except for the duration of operation, which was significantly shorter in group D (1.92 \pm 0.27) than in group M (2.20 \pm 0.19) p -value < 0.001 . In addition the group D was significantly less in blood loss (366 \pm 50.1

ml) than in the group M (394.5 \pm 35.2 ml) p -value = 0.005. As regard tachycardia there was statically significant difference with the highest in group M and then group D p -value = 0.05 (Table.2).

Table 2. Operative patients' characteristics

Variables	Group M (n=30)	Group D (n=30)	P-value
Duration of surgery (hours)	2.20 \pm 0.19	1.92 \pm 0.27	$< 0.001^*$
Fluid Maintenance (ml)	122.27 \pm 7.48	122.88 \pm 7.78	0.456
Blood Loss (ml)	394.5 \pm 35.2	366 \pm 50.1	0.005 [*]
Tachycardia	9 (30%)	3 (10%)	0.053
Bradycardia	11 (36.7)	18 (60%)	0.071

Continuous data are presented as (mean \pm SD), while categorical variables are presented as a percentage, MAP; Mean Arterial Pressure, * Significant.

At induction, the systolic blood pressure (SBP) in group M (121.2 \pm 4.36 mmHg) was statistically significantly higher than in group D (117.3 \pm 4.02 mmHg; p -value = 0.001). Furthermore, after five minutes (A5) the SBP in group M (117.3 \pm 4.24

mmHg) was statistically significantly higher than in group D (112.1 \pm 5.45 mmHg) p -value = 0.001. In addition, the blood pressure remained elevated in group M (112.8 \pm 73.78), (98.9 \pm 4.16) compared to group D (106.2 \pm 7.23), (95.5 \pm 3.56) at A15

and A30 (p-value = 0.001, 0.006). There was no statistically significant difference in (p-value > 0.05) between the study groups

(Group M & Group D) at (A45, A60, hypotensive agent discontinuation and after extubation) (Fig.1).

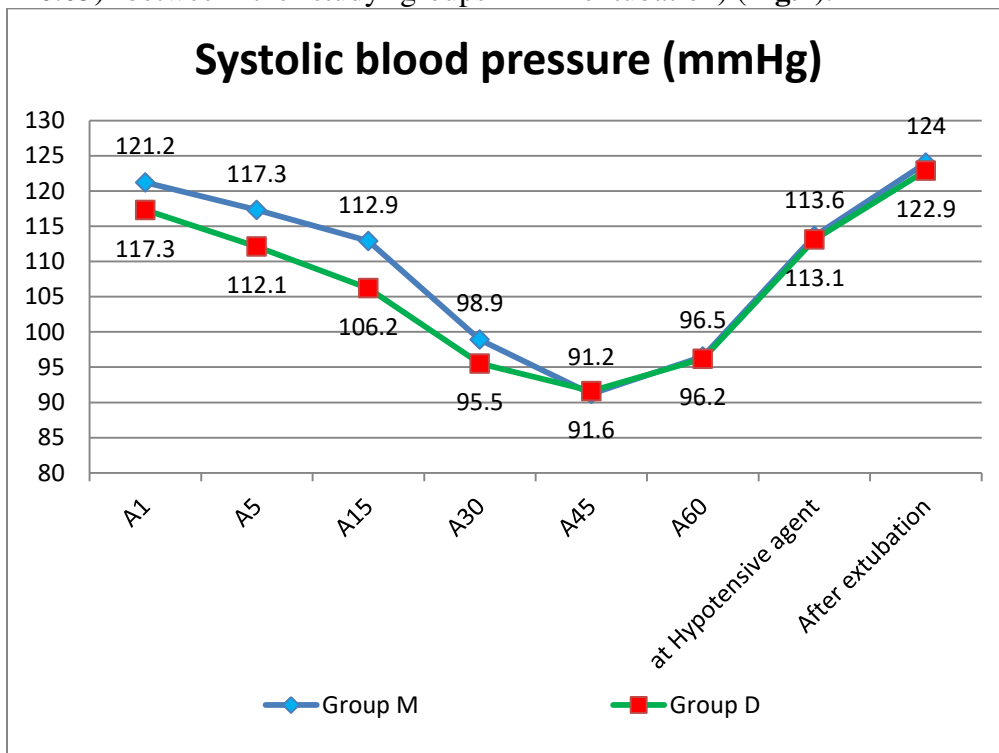


Fig.1. Comparisons of systolic blood pressure in the studied groups.

After 30 minutes of induction (A30), the diastolic blood pressure (DBP) in group M (61.07±3.12mmHg) was statistically significantly higher than in group D (59.1±2.25mmHg) p-value = 0.022. There was no statistically significant difference (p-

value > 0.05) in diastolic blood pressure between the (Group M & Group D) at (A1, A5, A15, A45, A60, hypotensive agent and after extubation) (Fig.2).

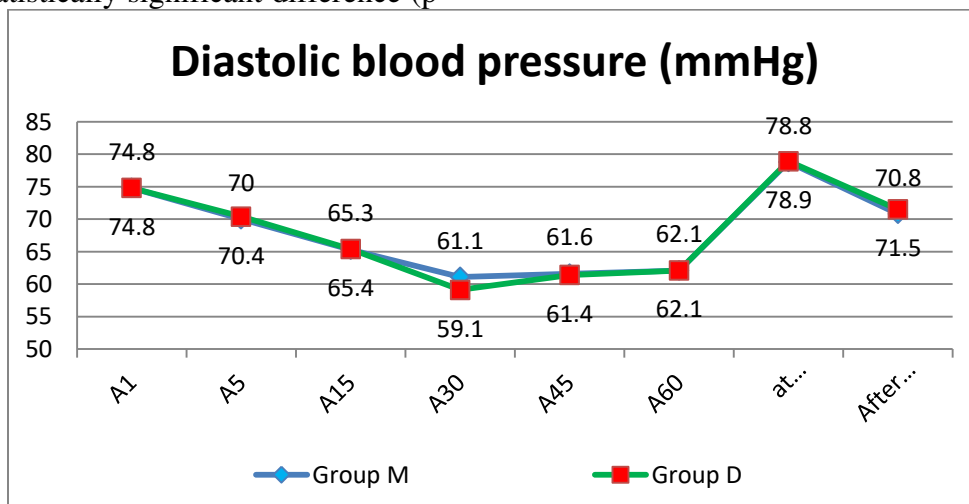


Fig.2. Comparisons of diastolic blood pressure in the studied groups.

There was no statistically significant difference (p -value > 0.05) between the study groups (group M & group D) regarding heart rate (HR) at (induction, A30, A45, A60 and hypotensive agent). While the HR was higher in group M at A5;

(80.63 ± 4.07), A15; (78.63 ± 3.23), and after extubation; (91.37 ± 5.21) than in group D at A5; (66.8 ± 4.66), A15; (66.6 ± 4.99), and after extubation; (88.9 ± 3.45) p -value < 0.001 , < 0.001 , 0.009 respectively (**Fig.3**).

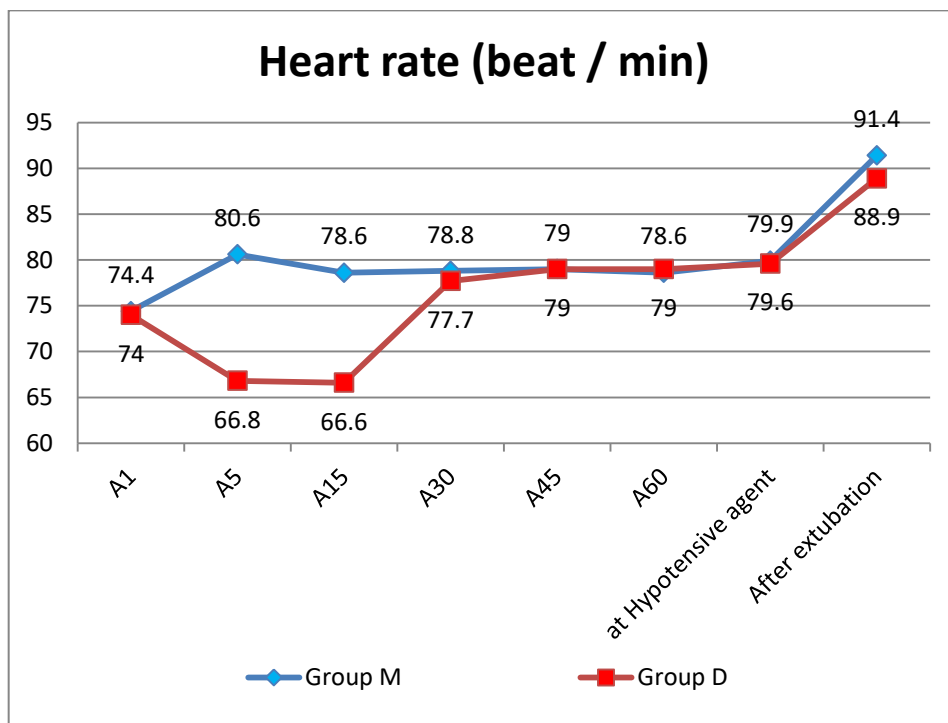


Fig. 3. Comparison of Heart Rate in the studied groups.

Significantly less time was required to restore the MAP in group M (16.04 ± 0.95) compared to group D (16.93 ± 1.1), p -value = 0.002 . While the extubation duration in group D (12.59 ± 0.54) was shorter than in group M (13.75 ± 0.67), the p -value < 0.001 .

In addition, the time necessary to administer the first analgesic to the patient in the PACU was longer in group D (19.8 ± 1.23) than in group M (18.2 ± 1), p -value < 0.001 (**Table.3**).

Table.3 Comparisons of time to restore MAP, Time to first analgesia and Extubation time in studied groups.

Variables	Group M (n=30)	Group D (n=30)	P-value
Time to Restore MAP (minutes)	16.04 ± 0.95	16.93 ± 1.1	0.002^*
Time to first analgesic rescue in PACU (minutes)	18.2 ± 1	19.8 ± 1.23	$< 0.001^*$
Extubation time (minutes)	13.75 ± 0.67	12.59 ± 0.54	$< 0.001^*$

Continuous variables described by (Mean \pm SD) where categorical variables were described by number and percent (N, %), * Significant, MAP; Mean Arterial Pressure, PACU; Post-Anesthesia Care Unit.

Aldrete score was better in group D (8.9 ± 0.8) than in group M (8.1 ± 0.8), p -value < 0.001 (Table.4). (Fig.4) demonstrates that

there is no statistically significant difference (p -value > 0.05) between the group M and group D in terms of VAS score (Pre & Post).

Table 4. Comparisons of Aldrete score in studied groups.

Variables	Group M (n=30)	Group D (n=30)	P-value
Aldrete score	8.1 ± 0.8	8.9 ± 0.8	$< 0.001^*$

Continuous variables described by (Mean \pm SD) where categorical variables were described by number and percent (N, %), * Significant.

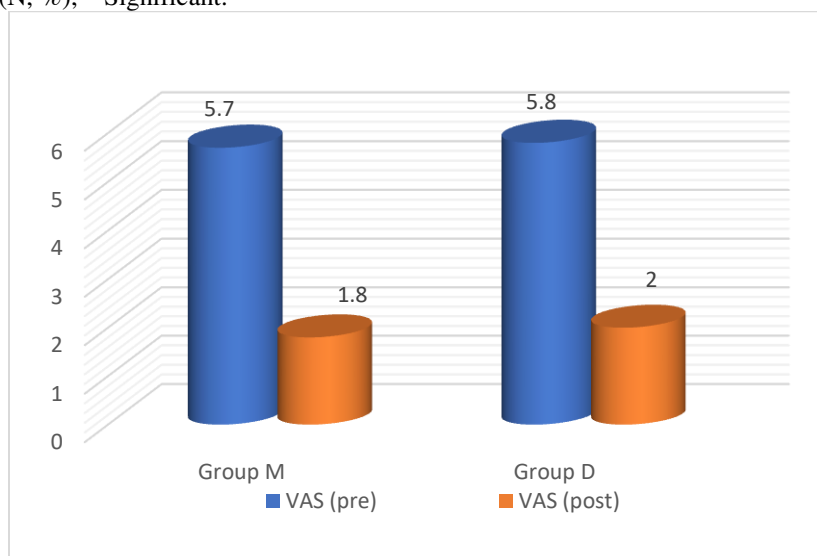


Fig. 4. Comparisons of VAS score (pre & Post) in studied groups.

Discussion

Higher SBP was noticed in Group M at induction, A5, A15, and A30 compared to Group D (p -value = 0.001). Also, after 30 minutes of induction (A30), the DBP in group M was statistically significantly higher than in group D p -value = 0.022.

HR was higher in group M at A5, A15, and after extubation than in group D p -value < 0.001 , < 0.001 , 0.009 respectively.

We concluded in this study that significantly less time was required to restore the MAP in group M (16.04 ± 0.95) compared to group D (16.93 ± 1.1), p -value = 0.002. While the extubation duration in group D (12.59 ± 0.54) was shorter than in group M (13.75 ± 0.67), the p -value < 0.001 . In addition, the time necessary to administer the first analgesic to the patient in the PACU was longer in group D (19.8 ± 1.23) than in group M (18.2 ± 1), p -value < 0.001 .

Dexmedetomidine was found to be superior to magnesium sulphate in a research by Rokhtabnak et al., with the former resulting in fewer individuals requiring nitroglycerine or analgesic rescue therapy due to high blood pressure. Statistically, the groups receiving dexmedetomidine, magnesium sulphate, and nitroglycerine all had shorter surgical times than the control group. Based on these findings, dexmedetomidine appears to be the most beneficial in terms of visual field and overall surgical time (Rokhtabnak et al., 2017).

In agreement with these findings, a study by Khalifa et al, comparing the use of dexmedetomidine, magnesium sulphate, and nitroglycerine during functional endoscopic sinus surgery found a statistically significant difference between the groups in the time required to restore the basal values of MAP,

with the dexmedetomidine group requiring significantly more time (Khalifa et al., 2015).

Somayaji and Raveendra found that after functional endoscopic sinus surgery, patients who were given dexmedetomidine had a significantly longer interval in which they did not report pain before requiring analgesia than patients in the control group (Somayaji et al., 2016).

Elsharnouby et al., who studied patients slated for endoscopic surgery, found statistically significant reductions in heart rate and mean blood pressure in the magnesium sulphate group, along with improved quality of vision of the surgical field and a shorter operative time compared with the control group (Elsharnouby et al., 2006).

There was a statistically significant difference in blood loss, with the lowest blood loss shown in the dexmedetomidine group, followed by the magnesium sulphate group. It was shown that the rate of blood transfusion was lowest in the dexmedetomidine group, followed by the magnesium sulphate group.

Similar results were seen in a research evaluating the use of nitroglycerine, magnesium sulphate, and dexmedetomidine during functional endoscopic sinus surgery (dexmedetomidine group had considerably less bleeding) (Bayram et al., 2015).

Both groups had comparable surgical data, except for the duration of operation, which was significantly shorter in group D (1.92 ± 0.27) than in group M (2.20 ± 0.19) p-value < 0.001 . As regard tachycardia there was statically significant difference with the highest in group M and then group D p-value = 0.05.

A further research by Vali et al. found that when doing posterior fixation surgery after traumatic spine surgery, patients who were given dexmedetomidine had much less blood loss than those who were given nitroglycerine. Transfusions were needed much more often in the

nitroglycerine group compared to the dexmedetomidine group (Vali et al., 2017).

Consistent with these findings, Vali et al. compared the use of nitroglycerine and dexmedetomidine in patients undergoing posterior fixation for a traumatic spine injury and found that the nitroglycerine group experienced significantly more episodes of tachycardia during the observation period, while the dexmedetomidine group experienced one case of hypotension and two cases of bradycardia (Vali et al., 2017).

The Aldrete score was better in group D (8.9 ± 0.8) than in group M (8.1 ± 0.8), p-value < 0.001 . Furthermore, we found that there was no statistically significant difference (p-value > 0.05) between the group M and group D in terms of VAS score (pre & post).

Conclusion

Dexmedetomidine is more advisable than Magnesium Sulphate for inducing hypotension in patients underwent posterior spine surgery as it has the most favorable hemodynamic profile with respect to blood pressure and heart rate, its ability to reduce surgical time, blood loss, need for blood transfusions, increase time to the first analgesic, achieve a better Aldrete score, and increase surgeon satisfaction.

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