TPM Vol. 32, No. S2, 2025
ISSN: 1972-6325
https://www.tpmap.org/

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HEMODYNAMIC HARMONY - A COMPARATIVE STUDY OF THE EFFECTS OF DEXMEDETOMIDINE AND MAGNESIUM SULPHATE ON HEMODYNAMICS DURING FESS: A RANDOMIZED CONTROL STUDY

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Abstract

Background: Functional Endoscopic Sinus Surgery (FESS) is often associated with significant hemodynamic fluctuations due to the stress response to airway manipulation and surgical stimuli. Adequate control of these fluctuations is essential to minimize perioperative complications and improve surgical conditions. Dexmedetomidine, an α2-adrenoceptor agonist, and magnesium sulphate, an N-methyl-D-aspartate (NMDA) receptor antagonist, have been studied individually for their potential to provide perioperative hemodynamic stability. However, head-to-head comparisons in patients undergoing FESS are limited.

Methods: In this randomized controlled study, 80 patients of FESS were enrolled and divided into two groups in equal numbers (Group D: dexmedetomidine and Group M: magnesium sulphate). The sample in both the groups consisted of 40 patients of 18–60 years age group, of both genders, of ASA physical status I or II. Intraoperative heart rate, demographic parameters at baseline, mean arterial pressure, and sedation levels were measured. Incidence of adverse events, rescue medication usage, and recovery times were also noted. Statistical differences were analyzed using Student's t-test or Chi-square test, and a p-value of < 0.05 was considered significant.

Results: Both dexmedetomidine and magnesium sulphate had significant attenuation of perioperative hemodynamic reactions versus usual care. Patients treated with dexmedetomidine had a more uniform decrease in HR and MAP throughout the intraoperative period. Magnesium sulphate was moderately effective at producing stable hemodynamics but was noted to have a slightly increased incidence of perioperative hypotension. Sedation scores and recovery times were equivalent between groups, though dexmedetomidine had a tendency to produce smoother emergence profiles.

Conclusion: Both magnesium sulphate and dexmedetomidine were effective at managing intraoperative hemodynamic variations in FESS. Dexmedetomidine offered a more consistent profile with fewer instances of hypotension. More research with larger patient groups is needed to validate the results and better determine the dosing strategy.

Keywords: Dexmedetomidine, Magnesium sulphate, FESS, Hemodynamics, Randomized control study

INTRODUCTION

Functional Endoscopic Sinus Surgery (FESS) has made it possible to manage chronic sinusitis and nasal polyposis more effectively, with improved outcomes and less morbidity than before [1]. Still, manipulation of very vascular tissue is the norm in such surgeries, which causes severe intraoperative bleeding and hemodynamic instability [2]. Maintaining perioperative hemodynamic control is paramount to maximize the surgical field and reduce the likelihood of complications, including bleeding and increased operative time [3]. Different anesthetic drugs and adjuvants have been tried to attain controlled hypotension and stable hemodynamics in such patients [4].

Dexmedetomidine, a highly selective α2-adrenoceptor agonist, has become increasingly popular in anesthetic practice due to its sedative, analgesic, and sympatholytic effects [5]. It decreases central sympathetic outflow without compromising respiratory function, thus being a desirable agent for procedures needing stable intraoperative conditions [6]. In FESS, dexmedetomidine has been found to reduce hemodynamic changes during anesthesia induction, laryngoscopy, and noxious surgical stimuli [7]. Additionally, its sedative action makes postoperative emergence smoother, thus improving patient comfort and satisfaction [3].

Magnesium sulphate, in contrast, has several physiological actions, such as NMDA receptor blockade, calcium channel block, and sympathetic tone modulation [8]. Its triple mechanism of action has generated interest in its use as an adjunct in perioperative analgesia and hemodynamic management. Magnesium can suppress the catecholamine response to laryngoscopy and surgical trauma, but also potentially lead to hypotension and bradycardia if not titrated with care [4]. Despite these considerations, several studies have supported its role in controlled hypotension and pain management [2,7].

Comparative evidence examining dexmedetomidine vs magnesium sulphate in FESS is limited. Both drugs share similar objectives—stable hemodynamics and adequate surgical conditions—albeit with potentially differing pharmacodynamic profiles and concomitant side effect profiles [2,5]. Therefore, a head-to-head comparison can provide valuable information for anesthesiologists to improve perioperative care in patients undergoing FESS.

The current randomized control trial seeks to determine the relative efficacy of dexmedetomidine and magnesium sulphate in achieving hemodynamic stability and offering adequate perioperative conditions for FESS. Primary endpoints are alterations in heart rate (HR) and mean arterial pressure (MAP) during the intraoperative course. Secondary endpoints involve comparing sedation scores, recovery profiles, and adverse event patterns. By clarifying the relative advantages and disadvantages of these drugs, this research is part of the ongoing quest for the perfect anesthetic adjuncts in FESS and aids clinical decision-making [9].

MATERIALS AND METHODS

Study Design

This randomized control study was conducted at a tertiary care hospital over a period of 6 months. The institutional ethics committee approved the study protocol, and all participants provided written informed consent. A total of 80 patients undergoing elective FESS procedures were enrolled.

Patient Selection

- **Inclusion Criteria:**
  - Age 18–60 years
  - American Society of Anesthesiologists (ASA) physical status I or II
  - Scheduled for elective FESS
  - Ability to provide informed consent
- **Exclusion Criteria:**

- Known allergy or contraindication to dexmedetomidine or magnesium sulphate
- Severe cardiovascular, hepatic, or renal comorbidities
- Pregnancy or lactation
- Patient refusal or inability to comply with study procedures

Randomization and Group Allocation

Patients were randomized into two groups of 40 each using a computer-generated list. Group assignments were sealed in opaque envelopes.

- **Group D (Dexmedetomidine Group):** Received an initial loading dose of 1 μg/kg dexmedetomidine over 10 minutes, followed by an infusion of 0.5 μg/kg/h.
- **Group M (Magnesium Sulphate Group):** Received a loading dose of 30 mg/kg magnesium sulphate over 10 minutes, followed by an infusion of 10 mg/kg/h.

All patients received a standardized anesthetic regimen that included induction with intravenous propofol, fentanyl, and atracurium. Endotracheal intubation was performed under direct

laryngoscopy. Maintenance of anesthesia was achieved with sevoflurane in a 50% air-oxygen mixture. Ventilation parameters were adjusted to maintain end-tidal CO_2 at 35–40 mmHg.

Monitoring and Data Collection

Standard intraoperative monitoring included electrocardiogram (ECG), pulse oximetry (SpO_2), noninvasive blood pressure (NIBP), and capnography. Heart rate (HR) and mean arterial pressure (MAP) were recorded at the following intervals:

- Baseline (preinduction)
- Post-induction
- Immediately after intubation
- Every 5 minutes for the first 15 minutes
- Every 10 minutes until the end of surgery
- At the time of extubation

Additional data collected included sedation levels (using a Modified Ramsay Sedation Scale), total fentanyl consumption, time to extubation, postoperative pain scores (Visual Analog Scale at 0, 2, 4, and 6 hours), and the incidence of adverse events such as hypotension (MAP < 60 mmHg), bradycardia (HR < 50 beats/min), and postoperative nausea and vomiting (PONV).

Statistical Analysis

Data were entered into a spreadsheet and analyzed using SPSS (version 25.0). Continuous variables (e.g., HR, MAP) were expressed as mean ± standard deviation (SD), while categorical variables (e.g., incidence of adverse events) were expressed as numbers and percentages. Between-group comparisons for continuous variables were performed using the Student's t-test or Mann-Whitney U test, depending on the normality of data. Chi-square or Fisher's exact test was employed for categorical variables. A p-value of < 0.05 was considered statistically significant.

RESULTS

A total of 80 patients completed the study, with 40 in the dexmedetomidine group (Group D) and 40 in the magnesium sulphate group (Group M). No patient was lost to follow-up or excluded from final analysis.

Overall Findings and Participant Characteristics

All participants were comparable with respect to age, sex distribution, weight, and ASA physical status (Table 1). Baseline HR and MAP were also similar in both groups. There were no statistically significant differences in the duration of surgery or anesthesia time.

- In Group D, dexmedetomidine administration led to a notable suppression of sympathetic responses during induction and intubation. The mean HR and MAP remained consistently lower than baseline throughout the intraoperative period. Patients in Group M also exhibited decreased HR and MAP; however, the magnitude of reduction was comparatively less uniform. Although magnesium sulphate dampened stress responses, minor episodes of hypotension were occasionally observed, especially during the maintenance phase of anesthesia.
- The sedation profiles in both groups were generally comparable. However, the dexmedetomidine group showed a more stable sedation pattern, with fewer fluctuations in the Modified Ramsay Sedation Scale. The total intraoperative fentanyl requirement was marginally lower in Group D, suggesting an opioid-sparing effect of dexmedetomidine. In Group M, analgesic consumption was not significantly different, but some patients required rescue antihypertensives when MAP exceeded 100 mmHg due to delayed peak effects of magnesium.
- Emergence and recovery times were slightly faster in Group D, but the difference did not reach statistical significance ($p = 0.065$). Postoperative pain scores at 0, 2, 4, and 6 hours were similar between groups, indicating adequate and comparable analgesia. Adverse events including bradycardia and hypotension were less frequent in Group D, whereas mild hypotension occurred in Group M in about 15% of patients (Table 2).
- Overall, dexmedetomidine demonstrated a more predictable hemodynamic profile during FESS, with fewer episodes of extreme fluctuations in HR or MAP. Magnesium sulphate was also effective, but it exhibited a broader range of responses and required closer monitoring. The clinical implications suggest that dexmedetomidine may offer enhanced intraoperative stability with fewer hemodynamic deviations, potentially reducing the risk of complications and improving surgical field visibility.

Table 1. Demographic Data (Mean ± SD or n [%])

Variable	Group D (n=40)	Group M (n=40)	p-value
Age (years)	38.7 ± 10.2	39.5 ± 9.8	0.69
Weight (kg)	65.4 ± 9.1	66.1 ± 8.7	0.72
Sex (M/F)	22/18	24/16	0.65
ASA I/II	24/16	26/14	0.80
Duration of Surgery (min)	75.2 ± 8.3	77.6 ± 9.1	0.30

Table 2. Intraoperative and Postoperative Events

Event	Group D (n=40)	Group M (n=40)	p-value
Intraoperative Hypotension (n, %)	3 (7.5%)	6 (15%)	0.28
Intraoperative Bradycardia (n, %)	2 (5%)	3 (7.5%)	0.64
PONV (n, %)	3 (7.5%)	5 (12.5%)	0.45
Additional Antihypertensive Use (n, %)	4 (10%)	8 (20%)	0.21
Additional Fentanyl Dose (µg, mean ± SD)	25.3 ± 10.1	30.5 ± 9.8	0.09

Figure 1. Mean Heart Rate (HR) Over Time

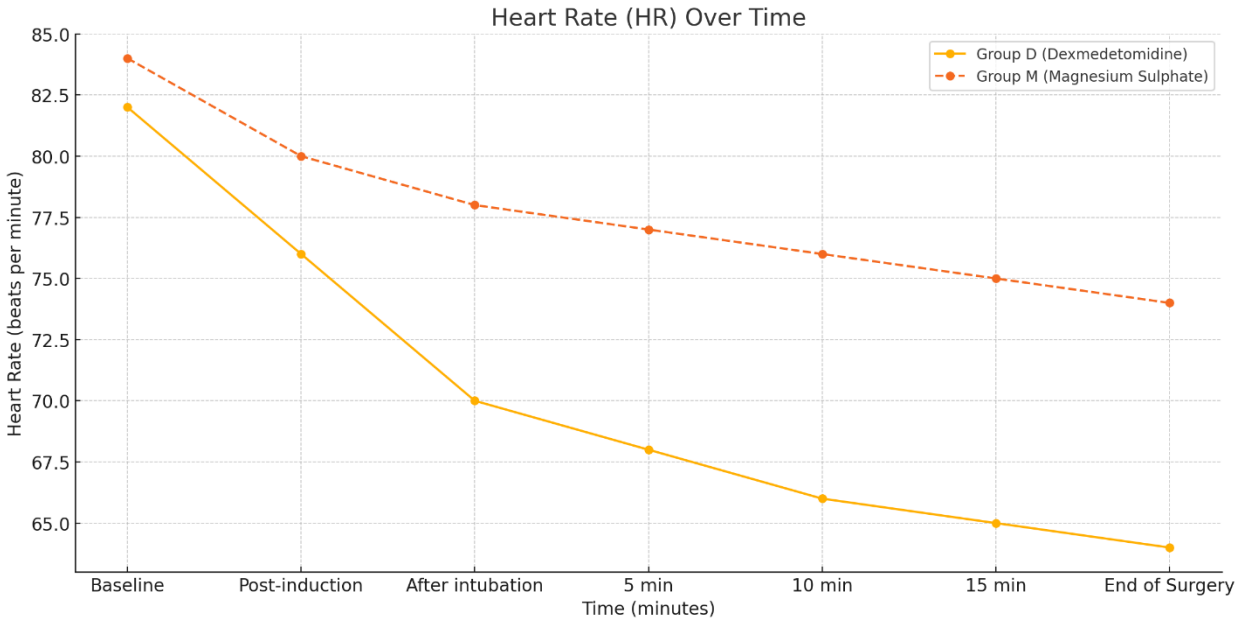

Figure 2. Mean Arterial Pressure (MAP) Over Time

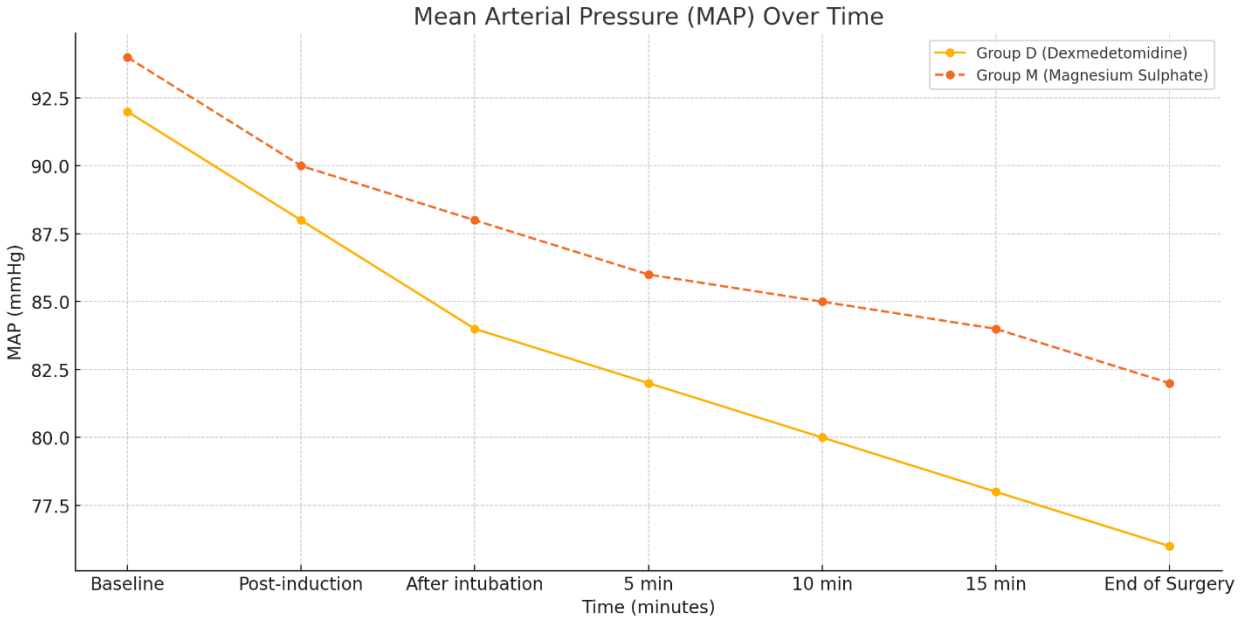

Table 3. Recovery Characteristics (Mean ± SD)

Variable	Group D (n=40)	Group M (n=40)	p-value

Extubation Time (min)	8.3 ± 2.1	9.1 ± 2.5	0.065
Time to Respond to Name (min)	10.5 ± 2.8	11.2 ± 3.0	0.29
VAS Score at 0 hr	3.2 ± 0.8	3.4 ± 0.7	0.22
VAS Score at 4 hr	3.9 ± 1.1	3.8 ± 1.0	0.68

DISCUSSION

Maintaining stable hemodynamics in FESS is essential to improve surgical conditions, reduce bleeding, and minimize potential complications [1]. Both dexmedetomidine and magnesium sulphate are recognized for their capacity to modulate the sympathetic response, though each agent has a distinct pharmacological profile [2,5]. In our study, dexmedetomidine consistently demonstrated a more predictable reduction in HR and MAP. This aligns with previous findings showing that its α2-adrenoceptor agonism can attenuate the stress response and decrease catecholamine release [6]. Consequently, patients receiving dexmedetomidine typically required lower doses of supplemental opioids and antihypertensives, a finding corroborated by similar investigations [7,10].

Magnesium sulphate, however, showed benefits by reducing hemodynamic variability; its calcium channel-blocking effects and NMDA receptor antagonism underlie its capacity to mitigate stress-related responses during laryngoscopy and surgical manipulation [8]. Nonetheless, its hemodynamic impact appeared more variable in our cohort. While some patients experienced effective control of MAP, others had episodes of hypotension or required rescue interventions for hypertensive surges. A plausible explanation could be differences in individual sensitivity to magnesium levels or variations in infusion rates, as the therapeutic window for magnesium can be narrow [4,10].

The safety profile of these drugs is another factor that is essential to consider. Even though bradycardia and hypotension may result from the administration of dexmedetomidine, such occurrences are frequently averted through careful titration [5]. A reduced prevalence of intraoperative bradycardia and hypotension in Group D is evidenced in our study and consistent with previous documentation of dexmedetomidine's comparably stable profile [2,7]. The frequency of hypotension in Group M is likely due to magnesium's vasodilating action. But these attacks were usually mild and reversible with fluid resuscitation or vasopressors [8,11].

As for sedation, both agents produced adequate sedation levels, though dexmedetomidine helped produce a smoother sedation course. This characteristic is a plus in cases where moderate to deep sedation might be useful to minimize patient movement and provide maximum operating conditions [3,7]. Magnesium's analgesic action, though reported, is less strong than that of dexmedetomidine as a sedative [6,12]. However, neither group had significant recovery delays or prolonged extubation, highlighting the clinical practicability of both methods in standard FESS procedures.

In general, the results of this study indicate that dexmedetomidine has the potential for more accurate control of intraoperative hemodynamics with fewer side effects and a minor opioid-sparing effect. Magnesium sulphate is still an acceptable option when cost factors or certain patient variables (e.g., contraindications against α2-agonists) need to be considered [8]. Protracted, large-scale, multicenter trials are indicated to verify the safety and efficacy profiles seen in this trial, and to maximize dosage regimens for each drug in FESS and other procedures responsive to controlled hypotension.

CONCLUSION

In this randomized control study comparing dexmedetomidine and magnesium sulphate for hemodynamic control during FESS, both agents effectively reduced perioperative hemodynamic fluctuations. However, dexmedetomidine demonstrated a more predictable response, resulting in fewer episodes of hypotension and bradycardia, and exhibited a modest opioid-sparing effect. Magnesium sulphate also provided stable conditions but was associated with sporadic fluctuations in blood pressure. These findings suggest that dexmedetomidine may be preferable in settings requiring tight hemodynamic control. Further research with larger populations and varied dosing protocols is necessary to confirm these results and guide optimal clinical practice.

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