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ORIGINAL RESEARCH **ANESTHESIA FOR EYE/ENT SURGERY**

A comparative study between dexmedetomidine versus magnesium sulphate for controlled hypotensive anesthesia in rhinoplasty surgeries

Sarah Amr Abbas Abd Elhalem [1], Ahmed Abd El Aala El-Shawarby [2], Karim Youssef Kamel Hakim [3], Yasser Ahmed Abdel Rahman [4], Ahmed Abdel Ghany Khalifa [5]

Author affiliations:

1. Sarah Amr Abbas AbdElhalem, MSc, Assistant Lecturer, Department of Anesthesia, Intensive Care & Pain Management, Faculty of Medicine, Ain Shams University Cairo, Egypt; E-mail: sarahabdelhalem@hotmail.com
2. Ahmed Abd El Aala El-Shawarby, Professor, Department of Anesthesia, Intensive Care & Pain Management, Faculty of Medicine, Ain Shams University Cairo, Egypt; E-mail: ah.elshawarby@gmail.com
3. Karim Youssef Kamel Hakim, Professor, Department of Anesthesia, Intensive Care & Pain Management, Faculty of Medicine, Ain Shams University, Cairo, Egypt; E-mail: karimyoussef@hotmail.com
4. Yasser Ahmed Abdel Rahman, Assistant Professor, Department of Anesthesia, Intensive Care & Pain Management, Faculty of Medicine, Ain Shams University, Cairo, Egypt; E-mail: yassera.salem@yahoo.com
5. Ahmed Abdel Ghany Khalifa, MD, Lecturer, Department of Anesthesia, Intensive Care & Pain Management, Faculty of Medicine, Ain Shams University, Cairo, Egypt; E-mail: ahmed.abdelghany@med.asu.edu.eg

Correspondence: Sarah Amr Abbas Abd Elhalem; **E-mail:** sarahabdelhalem@hotmail.com; **Tel:** +201060702202

ABSTRACT

Background: Rhinoplasty, a widely performed surgical procedure globally, necessitates hypotensive anesthesia to minimize bleeding, which can otherwise compromise surgical outcomes. Controlled hypotension anesthesia enhances the bloodless surgical area, reduces postoperative edema and ecchymosis, and can shorten the duration of the procedure. Many drugs have been used to attain hypotensive anesthesia, including magnesium sulfate, volatile anesthetics, and beta-adrenergic blocking agents. We compared dexmedetomidine with magnesium sulfate for producing hypotensive anesthesia in patients undergoing rhinoplasty.

Methodology: We included 42 patients, aged 18-60 y, undergoing rhinoplasty and allocated into Group D and Group M. Group D received dexmedetomidine 1 µg/kg diluted in 50 mL of normal saline, administered IV over 10 min prior to anesthesia. Group M received magnesium sulfate 40 µg/kg diluted as infusion. Both groups received continued infusions afterwards. General anesthesia was induced with propofol and atracurium, intubation done and maintained on sevoflurane in N_2O and O_2. Vital signs were monitored continuously. The efficacy of hypotensive anesthesia was assessed, along with the recording of postoperative complications and the surgeons' satisfaction.

Results: Group D and Group M showed no significant variation in mean arterial pressure. However, significant variation was observed in heart rate ($P < 0.05$). Group D had better operating area score compared to Group M. Surgeons; satisfaction was notably elevated in the Group D than in the Group M ($P < 0.05$). Opioids needed were significantly less in the Group D in contrast to the Group M. The amount of atropine needed was higher in the Group D than in the Group M ($P < 0.05$).

Conclusion: Dexmedetomidine proved to be better than magnesium sulfate in achieving hypotensive anesthesia together with providing optimal surgical field conditions. Although magnesium sulfate necessitated additional nitroglycerine, dexmedetomidine increased the risk of bradycardia but reduced the analgesic requirements compared to magnesium sulfate. These factors are crucial when considering the use of dexmedetomidine in rhinoplasty surgery.

Trial Registry: PACTR202408620568675.

Keywords: hypotensive anesthesia; magnesium sulphate; dexmedetomidine

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1. INTRODUCTION

Rhinoplasty is a plastic surgical procedure, where one of the primary challenges is to manage bleeding, as even minimal blood can significantly obstruct the surgeon's vision. Impaired clarity of the operating area ends up to expanded manipulations to surrounding tissues and extend the recovery period.[1,2] Hypotensive anesthesia minimizes bleeding at the operating field, thus enhancing visibility for the surgeon, allowing for more accurate performance.[3]

Hypotensive anesthesia was first described for maxillofacial surgeries in 1950 by Edenbergy. Many techniques and pharmacological agents have been described to carry off deliberate hypotensive anesthesia, but the best choice of the hypotensive agent is the one which offers easy administration, preservation of sufficient circulation to essential organs and scarcity adverse effect. [4] Most of the drugs, used to achieve hypotensive anesthesia, have an additional advantage to analgesic or sedative properties so these can be used with advantage. [4]

Dexmedetomidine, an alpha-2 agonist, which is known for its relaxing, antianxiety properties, and to decrease blood pressure in anesthesia. It has been also used for sedation in neuraxial anesthesia and used for pain management in the postoperative period. The pharmacological results of dexmedetomidine are due to the activation of the locus coeruleus of the pons specifically the alpha-2 adrenoceptors. Its hypotensive effect is due to its sympatholytic effect on alpha-2 adrenoceptors, so results in decreasing heart rate and cardiac output without decreasing the stroke volume. [5]

Magnesium sulfate was used as an agent to reach a good hypotensive anesthesia for several years in various surgeries. It regulates sympathetic tone and blood pressure by blocking calcium channel, which inhibits the release of norepinephrine. Additionally, magnesium acts as an N-methyl-D-aspartate receptor antagonist, that explains its effect on decreasing the need of anesthetics and opioids perioperatively. [6,7]

1.2. Study objectives

The principal end-result of this work was to compare the efficacy of dexmedetomidine versus magnesium sulfate to attenuate hemodynamics by recording blood pressure and pulse rates during rhinoplasty surgery. Secondary outcomes included production of bloodless operating area, and the frequency of postoperative nausea, vomiting or shivering. The need for analgesic (fentanyl), or atropine, nitroglycerine and ephedrine to maintain hemodynamics, was also recorded.

2. METHODOLOGY

This randomized, prospective, comparative study, took place from August 2022 to August 2023, at Ain Shams University Hospitals. It was approved by the research ethics committee of Faculty of Medicine, Ain Shams University (FMASU MD 224/2022), and registered with the Pan African Clinical Trial Registry, (identifier: PACTR202408620568675). Forty-two patients were included, aged 18-60 y, ASA physical status I and II, scheduled for elective rhinoplasty surgeries. Written informed consent was obtained from every patient.

Patients were randomized into two equal groups using a computer-generated random numbers list, with every group composed of 21 patients.

1st group (Group D) was the dexmedetomidine group in which patients received dexmedetomidine.

2nd group (Group M), the magnesium sulphate group received magnesium sulphate.

Exclusion criteria included withholding of the procedure or refusal to participate in the study, intraoperative hemodynamic instability, requirement for awake intubation, hypertension or ischemic heart disease, heart block, hepatic, renal, or cerebral impairment, familial coagulopathies, a history of allergy to the study drug.

The principal result of this work was measuring the mean arterial pressure (MAP) and pulse rate intraoperatively and postoperatively in PACU every 15 min; and the use of fentanyl, ephedrine, nitroglycerine, and atropine, as required. While the secondary outcomes were assessment of the surgical field by the operating surgeon as regards blood loss together with field clarity using a 6-point Liker scale. Also, during postoperative period, the groups were compared for the occurrence of the side effects; e.g., bradycardia, shivering, nausea, and vomiting, and the effect of each drug on these side effect.

2.1. Study Interventions

All patients underwent preoperative evaluations, and advised to fast for eight hours. Upon entering the operating room, intravenous cannula was secured, and lactated Ringer's solution administered. Non-invasive blood pressure, heart rate, electrocardiogram (ECG), and

pulse oximetry (SpO_2) were monitored throughout the perioperative period.

Patients enrolled in Group D received a loading dosage of 1 µg/kg of dexmedetomidine (Precedex, 200 µg/2 mL) diluted in 50 mL of normal saline, administered intravenously over 10 min prior to anesthesia. This was followed by an uninterrupted infusion of 0.4 to 0.6 µg/kg/h throughout the anesthesia.

Table 1: Comparison between groups as regard demographic data.

Demographic data		Group D (n = 21)	Group M (n = 21)	P-value
Age (y)		30.38 ± 6.0	32.29 ± 8.0	0.386 ^{t}
BMI (kg/m^2)		19.81 ± 1.0	19.88 ± 0.9	0.808 ^{t}
Gender	Male	11 (52.4)	14 (66.7)	0.351 ^{x2}
	Female	10 (47.6)	7 (33.3)	
ASA	I	14 (66.7)	12 (57.1)	0.53^{x2}
	II	7 (33.3)	9 (42.9)	

Data expressed as mean ± SD, proportion, t = student t test, X^2 = chi square

Patients in Group M received a loading dosage of 40 mg/kg magnesium sulfate diluted in 50 mL of 0.9 percent saline, administered intravenously over 10 min prior to anesthesia, followed by a continuous infusion of 10 to 15 µg/kg/h throughout the surgical intervention.

All patients were administered the same anesthetic protocol, consisting of propofol, fentanyl and atracurium. Anesthesia was maintained by 2% sevoflurane. Following the insertion of the endotracheal tube, all patients were placed on assisted ventilation in volume-controlled mode, with capnography used to ensure normocapnia.

MAP and pulse were measured as follows: prior to anesthesia, after intubation, at 5-, 10-, and 15-min post-intubation, and then at 15 min intervals throughout the surgery. These parameters were also recorded 2 min after epinephrine use, at the end of the surgical intervention, following extubation.

The surgeon evaluated the surgical field for bleeding and visibility using a 6-point Likert scale: 0 = no bleeding; 1 = minor bleeding, no aspiration required; 2 = minor bleeding, aspiration required; 3 = minor bleeding, frequent aspiration required; 4 = moderate bleeding, field visible only with aspiration; 5 = severe bleeding, continuous aspiration required. [8]

During postoperative period, the groups were compared for the side effects as bradycardia, shivering, nausea, and vomiting. [9]

2.2. Statistical analysis

PASS 11 was used for sample size calculation, setting power 99%, alpha error at 5% based upon a previous study results,.[10] which showed that the MAP after 60 min was higher among patients undergoing correction of scoliosis, who took dexmedetomidine than those who took magnesium. Based on these results, a sample size of at least 42 patients (21patients in each group) was required to achieve study objective.

Version 22.0 of the Statistical Package for Social Science was utilized to analyze the data. Quantitative data was presented as mean ± standard deviation (SD) or median (IQR) as appropriate. Frequency and percentage were used to express qualitative data. The Independent-samples t-test, the Chi-square (X2) test, and the Mann-Whitney U test were employed. The allowable margin of error was set at 5%, while the confidence interval was set at 95%. $P < 0.05$ was regarded as significant.

3. RESULTS

Patient's demographic data, in terms of age, sex, BMI and ASA, were comparable between groups with no significant variation between groups ($P > 0.05$) (Table 1).

Table 2: Comparative heart rates between the two groups

Time	Group D (n = 21)	Group M (n = 21)	P-value t
Baseline	64.33 ± 5.3	65.14 ± 5.6	0.633
induction	69.71 ± 6.6	67.76 ± 6.2	0.329
2 min	65.62 ± 7.2	69.57 ± 6.4	0.068
15 min	59.71 ± 4.9	65.00 ± 3.2	0.0002*
30 min	58.19 ± 5.7	65.00 ± 1.9	< 0.0001*
45 min	57.95 ± 4.9	63.71 ± 4.1	0.0002*
60 min	58.38 ± 6.6	64.19 ± 3.1	0.0007*
75 min	58.57 ± 8.3	60.67 ± 2.6	0.28
90 min	62.62 ± 4.4	61.19 ± 3.0	0.22
Extubation	69.19 ± 5.3	72.62 ± 2.6	0.011*

*Data expressed as mean ± SD, t = student t test; *P < 0.05 considered as significant*

Table 3: Comparative heart rates between the two groups in PACU

Time	Group D (n = 21)	Group M (n = 21)	P-value[t]
15 min	69.71 ± 3.6	71.19 ± 2.2	0.118
30 min	70.43 ± 3.8	71.62 ± 2.3	0.229
45 min	70.33 ± 4.5	70.81 ± 3.3	0.699
60 min	70.76 ± 3.5	71.14 ± 3.5	0.726

Data expressed as mean ± SD, t = student t test; P < 0.05 considered as significant

Table 4: Comparative intraoperative drug use

Intraoperative drugs used	Group D (n = 21)	Group M (n = 21)	P-value ^{X2}
Fentanyl	2 (9.5)	8 (38.1)	0.032*
Nitroglycerine	3 (14.3)	5 (23.8)	0.438
Atropine	5 (23.8)	0 (0)	0.019*
Ephedrine	No need		

*Data expressed as n (%), X2 = chi square; *P < 0.05 considered as significant*

Table 5: Comparison between groups as regard complications

Complications	Group D (n = 21)	Group M (n = 21)	P-value ^{X2}
Bradycardia	8	1	0.009*
Shivering	4	4	1
PONV	4	4	1

*Data expressed as n (%), X2 = chi square; *P < 0.05 considered as significant*

Table 6: Comparison between groups as regard surgical field score

Surgical field score	Group D (n = 21)	Group M (n = 21)	P-value ^{X2}
1	10 (47.6)	0 (0)	
2	10 (47.6)	5 (23.8)	
3	1 (4.8)	6 (28.6)	< 0.001
4	0 (0)	7 (33.3)	
5	0 (0)	3 (14.3)	

Data expressed as n (%), X2 = chi square

Intraoperative MAP didn't show any significant difference and Apart from heart rate at 15, 30, 45, and 60 min and extubation heart rate, heart rate showed no statistically significant variation linking the two groups. (Table 2).

Groups were comparable in PACU heart rate and showed no statistically significant variation linking the two groups (Table 3).

Groups were comparable in intraoperative drug use and showed statistically significant variation linking groups for fentanyl and atropine requirements (Table 4).

The groups complications were similar, apart from bradycardia, where both groups showed statistically significant variation between them. (Table 5). Groups were comparable in surgical field as well as there was analytically significant variation linking the groups (Table 6).

4. DISCUSSION

Rhinoplasty is a plastic surgical procedure, during which one of the main problems is bleeding, and even a minimal blood can block the surgeon's vision, making the surgery difficult and prolonging the surgical time.[1] By reducing bleeding at the surgical site, controlled hypotension offers the surgeon better visibility and technical freedom to work with more accuracy.[11]

Numerous methods have been studied to maintain a good operating field.[12] Most of the drugs used to achieve hypotensive anesthesia have an additional advantage to analgesia or sedative properties, so can be used to achieve a good balanced anesthesia plan to help in early and complete recovery of the patient.[4]

Our study compared the use of dexmedetomidine and magnesium sulfate to maintain a bloodless operative field during rhinoplasty through achieving adequate hypotension anesthesia, and the side effects of both drugs.

In our study the demographic data, including age, sex, body mass index and ASA physical status were equivalent in both groups. MAP in both groups remained equivalent, but there was a significant variation between the two groups regarding the heart rates. Bradycardia occurred in both groups and at times atropine was required, as was proved in previous studies. In the PACU both groups dexmedetomidine and magnesium sulphate didn't show any significant difference between the heart rate measurements.

In our study we also studied the need for vasoactive drugs. Nitroglycerine was used with 3 patients in Group D and in 5 patients in Group M, but the difference was not considered significantly different ($P = 0.438$). In contrast, a study in 2023 by Seyam et al. had the results in which magnesium group needed more nitroglycerine than dexmedetomidine group to control adequate hypotensive anesthesia.[11]

Atropine was used in 5 patients in Group D. when there was uncontrolled bradycardia while this didn't occur in the Group M. Fentanyl use was significantly different between the two groups ($P = 0.032$).

The incidence of post-surgery side effects was equivalent in both of the groups.

Regarding the surgical field quality our results concluded that dexmedetomidine was more successful in achieving bloodless operating field in rhinoplasty surgeries than magnesium sulphate ($P < 0.001$).

A study in 2022, compared dexmedetomidine with remifentanil to achieve adequate hypotensive anesthesia in rhinoplasty surgeries, results showed that more nitroglycerine was required in remifentanil group. [13]

In 2022, in functional endoscopic sinus surgery 80 adult patients received either dexmedetomidine or propofol to compare between them. Dexmedetomidine had a privilege than propofol in maintaining MAP and this preserved bloodless field.[14] Goswani et al. compared dexmedetomidine with clonidine to achieve deliberate hypotensive anesthesia experiencing corrective jaw surgeries. They concluded that both drugs are effective and safe in achieving controlled hypotension and clear surgical area for the surgeon.[15]

On the other hand, Farzad and associates assessed dexmedetomidine and remifentanil during rhinoplasty procedures. Both medications were shown to be effective. Hemodynamic variation in remifentanil was less than the dexmedetomidine. The dexmedetomidine caused better surgical field than remifentanil, as it was with our findings. [16]

In 2020, a study summarizing ten randomized previous studies compared the effectiveness and safety of dexmedetomidine in contrast to magnesium sulphate in carrying out hypotensive anesthesia. Consistent with our findings regarding hemodynamics, the variation was remarkably less in individuals receiving dexmedetomidine in contrast to those receiving magnesium sulphate. [9]

Faranak et al. in 2021 studied the result of different doses of dexmedetomidine to carry out hypotensive anesthesia in rhinoplasty surgeries and the prevalence of bradycardia intraoperatively. It showed that bradycardia occurred with the higher loading doses of 1 µg/kg. [17]

Seyam's and faranak studies agree with our results, and the need of opioids was less in dexmedetomidine compared to the magnesium group.[5,11]

In a meta-analysis, which included 10 trials they concluded that lower rates of nausea and vomiting were found with dexmedetomidine than with magnesium sulphate.[9] A double blinded trial in 2020 assessed the efficacy of magnesium sulphate to achieve hypotensive anesthesia in rhinoplasty surgeries. Patients in the magnesium sulfate group also experienced better recovery in terms of less side effects. [6]

5. LIMITATIONS

The trial included patients with specific age group and medical history. Consequently, the results cannot be generalized to other patient groups. Additionally, the representative sample groups were insufficient to detect negative incidents that might happen at a low prevalence.

6. CONCLUSION

To achieve regulated hypotension and create a favorable bloodless surgical field in rhinoplasty surgeries,

dexmedetomidine proved to be more efficacious than magnesium sulphate. Nitroglycerine was frequently needed as an adjuvant to magnesium sulphate to achieve a comparable level of hypotension. In spite of the fact that bradycardia is an advantage with hypotensive anesthesia, yet it occasionally reaches a hazardous level which requires careful attention when using dexmedetomidine as a hypotensive agent. The use of dexmedetomidine proved to require less doses of analgesic agents as compared to magnesium sulphate.

7. Future scope:

Dexmedetomidine has gained publicity for fulfilling hypotensive anesthesia, enhancing operation area quality, minimizing oozing, and increasing surgeon satisfaction in procedures that require a bloodless field, such as rhinoplasty surgery.

8. Ethics approval and consent to participate:

This study was approved by the research ethics committee at the faculty of medicine, Ain Shams University (FMASU MD 224/2022) and registered retrospectively with Pan African Clinical Trial Registry, identifier: PACTR202408620568675. Written informed consent was obtained from all patients.

9. Availability of data

The datasets produced and/or analyzed during the current study are available from the corresponding author on reasonable request.

10. Competing interests

The authors declare that there were no conflicts of interest. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

11. Authors contribution

SA: conduction of the study work.

AA: manuscript editing.

KY:

YES: statistical analysis, and review

AA: Literature search.

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