REVISTA BRASILEIRA DE ANESTESIOLOGIA

Official Publication of the Brazilian Society of Anesthesiology
www.sba.com.br

SCIENTIFIC ARTICLE

Comparison of the effects of magnesium sulphate and dexmedetomidine on surgical vision quality in endoscopic sinus surgery: randomized clinical study

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Abstract

Background and objectives: Even a small amount of bleeding during endoscopic sinus surgery can corrupt the endoscopic field and complicate the procedure. Various techniques, including induced hypotension, can minimize bleeding during endoscopic sinus surgery. The aim of this study was to compare the surgical vision quality, haemodynamic parameters, postoperative pain, and other effects of magnesium, a hypotensive agent, with that of dexmedetomidine, which was initially developed for short-term sedation in the intensive care unit but also is an alpha 2 agonist sedative.

Method: 60 patients between the ages of 18 and 45 years were divided into either the magnesium group (Group M) or the dexmedetomidine group (Group D). In Group M, magnesium sulphate was given at a pre-induction loading dose of $50\,mg\,kg^{-1}$ over $10\,min$ and maintained at $15\,mg\,kg^{-1}\,h^{-1}$; in Group D, dexmedetomidine was given at $1\,mcg\,kg^{-1}$ $10\,min$ before induction and maintained at $0.6\,mcg\,kg^{-1}\,h^{-1}$. Intraoperatively, the haemodynamic and respiratory parameters and 6-point intraoperative surgical field evaluation scale were recorded. During the postoperative period, an 11-point numerical pain scale, the Ramsay sedation scale, the nausea/vomiting scale, the adverse effects profile, and itching parameters were noted.

Results: Group D showed a significant decrease in intraoperative surgical field evaluation scale scale score and heart rate. The average operation time was $50\,min$, and Group M had a higher number of prolonged surgeries. No significant difference was found in the other parameters.

Conclusions: Due to its reduction of bleeding and heart rate in endoscopic sinus surgery and its positive impacts on the duration of surgery, we consider dexmedetomidine to be a good alternative to magnesium.

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PALAVRAS-CHAVE
Cirurgia endoscópica sinusal;
Sulfato de Magnésio;
Dexmedetomidina;
Hipotensão

Comparação dos efeitos de sulfato de magnésio e da dexmedetomidina sobre a qualidade da visibilidade em cirurgia endoscópica sinusal: estudo clínico randomizado

Resumo

Justificativa e objetivo: Uma quantidade, mesmo pequena, de sangramento durante a cirurgia endoscópica pode alterar o campo endoscópico e dificultar o procedimento. Várias técnicas, incluindo hipotensão induzida, podem minimizar o sangramento durante a cirurgia endoscópica. O objetivo deste estudo foi comparar a qualidade da visibilidade cirúrgica, os parâmetros hemodinâmicos, a dor no período pós-operatório e outros efeitos do sulfato de magnésio, um agente hipotensor, com os da dexmedetomidina, inicialmente desenvolvida para sedação em curto prazo em unidade de terapia intensiva, mas que também é um sedativo agonista alfa-2.

Métodos: Foram alocados 60 pacientes entre 18 e 45 anos em dois grupos: Grupo M (magnésio) e Grupo D (dexmedetomidina). No Grupo M, sulfato de magnésio foi administrado pré-indução a uma dose de carga de $50\,mg\,kg^{-1}$ por 10 minutos e mantida com $15\,mg\,kg^{-1}\,h^{-1}$; no Grupo D, dexmedetomidina foi administrada a uma dose de $1\,mcg\,kg^{-1}$ 10 minutos antes da indução e mantida com $0,6\,mcg\,kg^{-1}\,h^{-1}$. No período intraoperatório, foram registrados os parâmetros hemodinâmicos e respiratórios e a avaliação do campo cirúrgico com uma escala de seis pontos. Durante o período pós-operatório foram registrados os valores da escala numérica de 11 pontos para avaliar a dor, a escala de sedação de Ramsay, a escala de avaliação de náusea/vômito, o perfil dos efeitos adversos e pruridos.

Resultados: O Grupo D apresentou redução significativa da frequência cardíaca e do escore na escala de avaliação do campo cirúrgico intraoperatório. A média do tempo cirúrgico foi de 50 minutos e o Grupo M apresentou um número maior de cirurgias prolongadas. Não houve diferença significativa em outros parâmetros.

Conclusão: Por causa da redução da taxa de sangramento e da frequência cardíaca em cirurgia endoscópica e dos impactos positivos sobre a duração da cirurgia, consideramos dexmedetomidina como melhor opção que o sulfato de magnésio.

Introduction

Endoscopic sinus surgery (ESS) is a form of surgical intervention in which surgical visualization may diminish completely with only a small amount of bleeding.[1] This surgery is done under endoscopic magnification in a narrow area where manipulation is difficult.

Therefore, hypotensive bleeding control during the operation may help to increase surgical visualization. Different anaesthetic techniques and drugs are being explored and tested to help to solve this problem.[2-4] Magnesium is one drug used for this purpose, and its positive effects on the control of postoperative bleeding have been clearly defined.[5,6] Magnesium is an N-methyl-D-aspartate (NMDA) receptor antagonist that reduces the need for analgesic and sedative drugs. Dexmedetomidine is also an alpha 2 agonist; it has sedative, amnestic, and analgesic properties.[7] Additionally, it has a decongestant effect and induces hypotension in tympanoplasty surgeries.[8,9] Dexmedetomidine has been also used in ESS patients under local anesthesia,[10,11] as well as in septoplasty and tympanoplasty patients under general anaesthesia; it has been stated that it decreases the bleeding score and reduces the required amount of fentanyl.[12]

Therefore, in our study we compared the effects of magnesium and dexmedetomidine, which are used during ESS in patients under general anaesthesia, primarily on surgical vision quality and on haemodynamics and postoperative analgesia.

Methods

After the approval of the University of Abant Izzet Baysal Clinical Research Ethics Committee, document number 2011/97, we enrolled 60 patients of the American Society of Anesthesiologists (ASA) risk classification I–II according to the pre-anaesthetic evaluation, ranging from 18 to 45 years of age who were scheduled to have an elective functional ESS operation. The patients were randomly divided into two groups of 30 people: the magnesium group (Group M) and the dexmedetomidine group (Group D). The control group without hypotensive drugs was not used due to ethical concerns, and the two agents were compared. Patients who were allergic to any of the drugs that would be used in the study, those who had hypermagnesaemia, were opioid-dependent, had severe cardiac, renal, neurological, and liver diseases, and had a history of postoperative nausea/vomiting were excluded from the study.

In the preoperative evaluation, all patients were asked to provide oral and written informed consent for the anaesthesia and research; those who accepted and signed were included in the study. The patients were informed about the method of anaesthesia, and their adaptation to the study was implemented by explaining the 11-unit Numerical Pain Scoring (NPS11) Scale, Ramsay Sedation Score, and nausea/vomiting scale. These parameters were recorded immediately after surgery and then thereafter at intervals of 5 min.

Prior to surgery, the patients were taken to the preoperative preparation room, and 0.5 mg atropine sulphate (Atropine ampoule, 0.5 mg mL^{-1}, Biofarma, Istanbul, Turkey) and midazolam 0.1 mg kg^{-1} (Dormicum 1 mg mL^{-1}, Roche müstahzarlari san, Istanbul, Turkey) were applied intramuscularly 30 min before the patients were taken to the operating table.

In the operating room, all patients who were given O_2 at 2 L min^{-1} with a nasal cannula received electrocardiogram monitoring, and the heart rate (HR), mean arterial pressure (MAP), peripheral oxygen saturation (SpO$_2$), and respiratory rate (RR) were also monitored (Drager Infinity XL monitor). Anaesthesia was induced with 50 mcg fentanyl (fentanyl citrate flakon 50 mcg mL^{-1}, Meditera Ltd. Istanbul, Turkey), 1.5 mg kg^{-1} propofol (Propofol 1% Fresenius, Istanbul, Turkey), and 0.5 mg kg^{-1} rocuronium bromides (Esmeron 5 mg flakon, Organon, Istanbul). Anaesthesia was maintained with 50% O_2, 50% N_2O, and 1.5% sevoflurane (Sevorane, Abbott, Istanbul, Turkey). Muscle relaxation was maintained with 0.15 mg kg^{-1} rocuronium bromide and used when needed.

Patients were randomly divided into two equal groups by the closed card method by a supervisor who did not participate in the other sequences of the study. In Group M, the infusion of magnesium sulphate was started before induction at a loading dose of 50 mg kg^{-1} for 10 min, and then was sustained throughout the operation at a maintenance dose of 15 mg kg^{-1} h^{-1} intravenously. In Group D, before induction, 1 mcg kg^{-1} for 10 min of dexmedetomidine was given by infusion, and during the operation, the maintenance dose of 0.6 mcg kg^{-1} h^{-1} was administered. After induction, the operation table was positioned in a 10° reverse Trendelenburg position, and 1 mL of local anaesthetic was applied to the pterygopalatine fossa (Lidocaine hydrochloride 20 mg mL^{-1}, Epinephrine base 0.0125 mg mL^{-1} (Jetokain ampoule 2 mL, Adeka, Istanbul)). The intubation tube was fixed with adhesive tape around the mouth. Positive end-expiratory pressure (PEEP) was limited to 1 cm H_2O. The total duration of the operation was recorded. At the end of surgery, the muscle relaxation effect was antagonized with the use of atropine 0.01 mg kg^{-1} and neostigmine 0.05 mg kg^{-1}. Surgical team, postoperative measurement teams (anesthesiology assistants) and patients were unaware of the drugs that had been used.

Patients were followed up prior to intubation and also 1, 2, 3, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, and 90 min after intubation in terms of MAP, RR, SpO$_2$, nausea/vomiting, itching, adverse effects, complications of anaesthesia, and surgical complications. At the end of the operation, when the body temperature of the patients was >36 degrees Celsius and their modified Aldrete score was = 9, they were extubated, and postoperative follow-up was done. Patients were evaluated before extubation and 0, 5, 10, 20, 30, 60 min after extubation in terms of MAP, RR, SpO$_2$, nausea/vomiting, itching, adverse effects, complications of anaesthesia, and surgical complications. In the postoperative period, 4-point nausea/vomiting scale for nausea, 11-unit Numerical Pain Scoring (NPS11)[13] for pain evaluation, Ramsay Sedation Scale for the sedation degree, and Intra Operative Surgical Field Evaluation (IOSFE) Scale[14] to measure bleeding at the surgical area were employed. This scale was used because any blood aspirated from the bleeding

Table 1 Intraoperative surgical field evaluation scale: IOSFE: Boezaart Scale.

No bleeding	0
Slight bleeding – no suctioning of blood required	1
Slight bleeding – occasional suctioning required. Surgical field not threatened	2
Slight bleeding – frequent suctioning required. Bleeding threatens surgical field a few seconds after suction is removed	3
Moderate bleeding – frequent suctioning required. Bleeding threatens surgical field directly after suction is removed	4
Severe bleeding – constant suctioning required. Bleeding appears faster than can be removed by suction. Surgical field severely threatened and surgery not possible.	5

area mixes with the washing solution, and the amount of liquid escaping to the stomach greatly varies from patient to patient and prevents mathematical calculations from being done on the basis of the liquid accumulated in the aspirator alone. Table 1 shows the IOSFE scale. Nausea and vomiting scale was described as follows: no nausea/vomiting, mild nausea/vomiting (treatment not indicated), moderate nausea/vomiting (treatment indicated) and severe nausea/vomiting (resistive to treatment).

In case of intraoperative anaesthetic depth failure, 1 mcg kg^{-1} of fentanyl (fentanyl citrate, flakon 50 mcg mL^{-1}, Meditera Ltd., Istanbul, Turkey) intravenously (IV) was available.

For postoperative analgesia, 1 mg kg^{-1} of pethidine HCL was given intramuscularly (IM) (Aldolan ampoule 100 mg, 2 mL, Liba Ilac Sanayi) when the NPS11 value was 4 or more; for nausea/vomiting, 0.25 mg kg^{-1} IV of metoclopramide (Avil ampoule, 50 mg, 2 mL, Istanbul, Turkey) was on hand.

Statistical analysis was done via the SPSS 11.5 statistical package (SPSS, Chicago, IL, USA). For the IOSFE scale, the Mann–Whitney U test was used to compare the mean values between groups. Calculations were performed with independent t tests for the average of numerical data distributed normally and with the Chi-square test using a cross-table for the frequency analysis of data, such as the percentage of males vs. females. When calculating the number of participants to include in the study, the following parameters were used: the IOSFE Scale, which was the primary output, needed to have an average value of 2 or 3 between similar study groups; the approximate standard deviation should be close to 1.1; the alpha error margin should be 0.05 with the consideration of bipolar probability and abnormal logistic character of the distribution; the power value (1-beta) needed to be 0.95; and the sample size was calculated as 30 per group.

Results

The demographic data and the operation duration of the patients included in the study are presented as an average value in Table 2 and there is no statistical significance. The

Table 2 The average value of patients' age, weight, and duration of operation.

Each group's n = 30	Age	Weight	Duration of Op.
Mg			
Mean ± SD	42.9 ± 15.1	74.9 ± 12.1	50.2 ± 18.6
% 95 CI	*37.3–48.5*	*70.4–79.4*	*43.2–57.1*
Dex			
Mean ± SD	42.5 ± 16.1	74.9 ± 13.4	51.0 ± 14.8
% 95 CI	*36.5–48.6*	*69.9–79.9*	*45.5–56.5*

SD, standard deviation; CI, confidence interval.

female/male ratio was 8/22 in Group M and 12/18 in Group D, and there was no significant difference between the two ($p = 0.273$).

Mean arterial pressure (MAP) analysis revealed that the blood pressure was lower for a short period of time in Group D at the 35th and 65th min. The p-values of the minutes at which a significant difference was observed are given in Fig. 1. The data shown at the left side of the dashed line indicate that the first 88% of the cases were completed in less than 70 min.

No difference was detected during and after the operation in the values of SpO_2 and respiratory rates, or from extubation until the first postoperative hour in the values of the nausea/vomiting scale and the NPS11. None of the patients needed intraoperative fentanyl or postoperative analgesic, anti-emetics, or anti-pruritic agents.

In the analysis of HR, from the pre-intubation period until the 20th min and at the 35th, 40th, and 45th min, it was observed that the HR was significantly slower in Group D. As shown in Fig. 2, the course of the HR values at the following minutes is presented with p-values and the line, indicating that 88% of the cases were completed.

It was noted that the confidence interval of the surgery duration was wider in Group D.

The longest case was 90 min in Group M, and the shortest case was 20 min, of which there was one case in both the groups. Six cases in Group M and one in Group D took longer than 70 min. When these frequencies were compared, a significant difference in favour of Group D was observed ($p = 0.044$). The percentage of the cases that lasted more than 70 min was significantly higher in Group M than in Group D.

The target output of our study was the IOSFE scale, and it had a significantly low level statistically in Group D at the 5th, 10th, 20th, 30th, 45th, and 60th min, as shown in Table 3. In both groups, the international normalized ratio (INR) values of patients were lower than 1.33.

Discussion

In our study, no significant difference was found in terms of age, weight, gender, and duration of operation between the two groups. For HR, significant and meaningful decelerations were observed in Group D from the operation's start
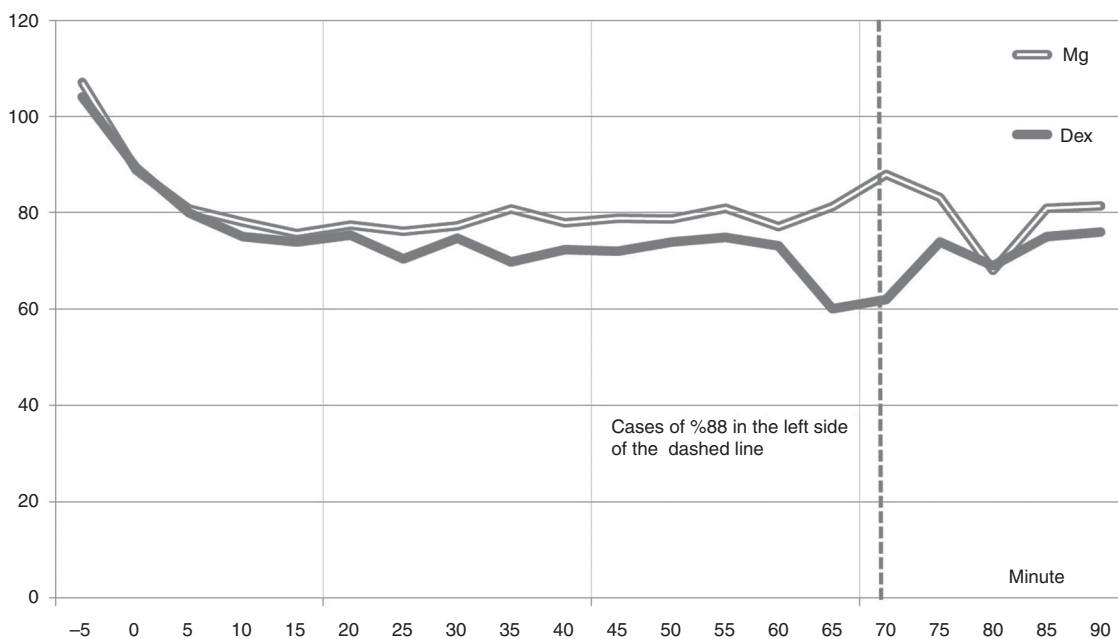

Figure 1 The 95-min course of MAP values and the border line indicating that the first 88% of the cases were completed in less than 70 min; p-values of the difference observed at the 35th and 65th min were 0.005 and 0.023, respectively.

Table 3 The IOSFE Scale: Mean ± SD, % 95 CI and P-values.

Time	05	10	15	20	30	45	50	60
Mg								
Mean ± SD	2 ± 1.	2.5 ± 1	2.6 ± 1	2.5 ± 0.5	2.3 ± 0.5	2.5 ± 0.5	2.5 ± 0.5	2.7 ± 0.6
% 95 CI	*1.2–2.7*	*1.8–3.1*	*1.9–3.3*	*2.1–2.8*	*2.0–2.7*	*2.1–2.8*	*2.1–2.9*	*2.3–3.2*
Dex								
Mean ± SD	1.3 ± 0.6	1.4 ± 0.8	1.5 ± 0.8	1.8 ± 0.9	1.7 ± 0.9	1.7 ± 0.9	1.8 ± 0.8	1.5 ± 1
% 95 CI	*0.9–1.7*	*0.9–1.8*	*1.0–2.0*	*1.2–2.3*	*1.2–2.2*	*1.2–2.2*	*1.5–2.3*	*1–2.1*
p	*0.001*	*0.000*	*0.005*	*0.024*	*0.001*	*0.000*	*0.001*	*0.002*

SD, standard deviation; CI, confidence interval.

until the 45th min. The decelerations lasted for a total of 35 min. Considering that the average duration of the surgical procedure was 50 min, it can be inferred that dexmedetomidine provided a notable decrease in HR during the majority of the surgery compared to magnesium. The positive effects of a decrease in HR on bleeding are known.[2] When the MAP was compared, no significant difference between the two drugs in terms of blood pressure was identified due to the observation of decreases occurring only at the 35th and 65th min, the total decrease time being 10 min, and this time remaining shorter in regard to average operation time.

We did not use a control group in the study because we considered it unethical not to try to control bleeding in the surgical field without active precautions, such as deliberate hypotension to reduce bleeding; also the surgical team demanded. Pre- and postoperative haemoglobin values were not compared in this study because the blood lost during ESS is low enough not to expect any significant laboratory measurement differences every time, although even small amounts restrict surgical vision in a narrow operative field.[11,15,16] While the total blood lost does not require transfusion (100–300 mL), numerous techniques to reduce bleeding have been developed due to the loss of vision in the surgical area when blood is present.[5,11,17–21] Some of these are steroids, tranexamic acid, deliberate hypotension agents, sevoflurane, total intravenous anaesthesia (TIVA), and various patient positions. The literature has shown that a lack of vision in the surgical field extends the duration of the operation and increases the rate of complications.[22–25] In the majority of publications that have investigated the issue, surgical field clarity outranked the amount of bleeding. Other studies[11] have been unable to find a significant difference between postoperative haemoglobin values and have identified differences in surgical field evaluation; similarly,
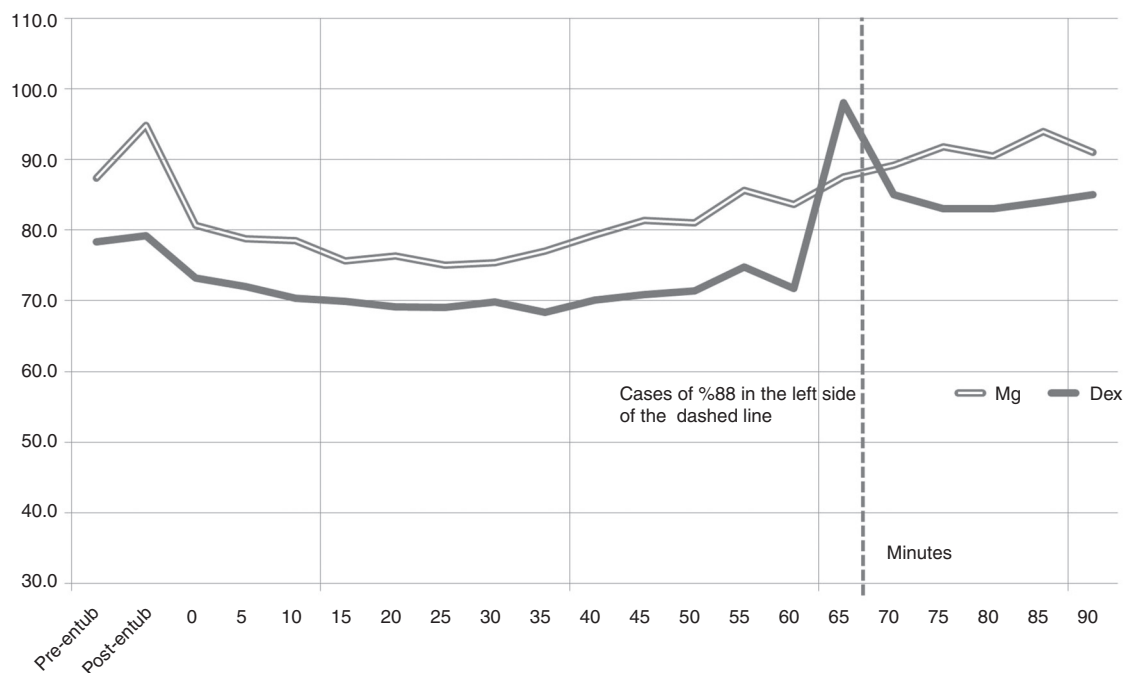

Figure 2 The Course of Heart Rate (HR) Values During the Operation. The *p*-values of the minutes at which a difference was observed: before intubation, after intubation, 0, 5, 10, 20, 35, 40, and 45 min, *p*-values, respectively: 0.012, 0.000, 0.008, 0.029, 0.007, 0.032, 0.028, 0.032, and 0.034.

studies have found different levels of bleeding between two groups but have indicated that this difference does not affect surgical vision.[23] Not all blood leaks that occur during endoscopic sinus surgery are observed in the front part of the surgical area; the leaks can sometimes find their way outside of the visible field and reach the pharynx. This situation explains why the amount of haemorrhage and the surgical vision quality are sometimes irrelevant.

In our study, no statistical difference was found in terms of the mean duration of surgery ($p = 0.74$). However, 96.6% of the cases in Group D were completed before 70 min, whereas in Group M, this percentage was 80%. When the distribution of the cases of both groups that lasted more than 70 min was compared with the total group number via frequency analysis, the probability value was $p = 0.044$. In other words, in Group M, more patients required a prolonged surgery. This observation supported the limitation of vision in the surgical field.

In many studies that have researched the drugs used to reduce bleeding in endoscopic sinus surgery, the effects of the aforementioned drugs on the need for postoperative analgesics have also been investigated and presented as a secondary outcome. Some studies have argued that the pain was less in these surgeries.[26] In our study, regardless of the group, all of the NPS11 values were = 4, which is the recommended value to provide preemptive analgesics in the postoperative period, so that point was never reached. When the NPS11 values were analyzed, no significant difference was found at any of the measurement points in the first postoperative hour.

Some publications suggest that TIVA is preferable to inhalation anaesthesia in endoscopic sinus surgery.[27] Whether they fit the definition of TIVA or not, the importance of evoked hypotension provided by some intravenous agents is obvious.[20,21,28] Propofol and remifentanil are only some of them.

Magnesium is an agent that has been indicated to decrease MAP under general anaesthesia and reduce the HR, as well as to lessen the need for anaesthetic substance and to reduce bleeding. It also makes a positive contribution to the postoperative pain score.[29]

Magnesium also does not cause reflex tachycardia when used as an intraoperative hypotensive agent, does not produce reflex hypertension, and does not lower cardiac output.[30] In a randomized, double-blind, and placebo-controlled clinical trial conducted with 60 patients scheduled for endoscopic surgery, they found a statistically significant lower HR and MAP in the magnesium group than they did in their control group.[5] Also, the quality of vision of the surgical field was higher in the magnesium group. In the same study, the operative time in the control group was significantly prolonged, whereas in the magnesium group, the duration of anaesthesia had been prolonged depending on the postoperative awakening. However, in operations that require general anaesthesia, a partially disadvantageous feature of magnesium is that it reduces acetylcholine release[31] and extends the effects of neuro-muscular blockers;[32] some publications have also indicated different effects on clotting mechanisms.[33]

Dexmedetomidine is a drug that is not yet approved in the United States by the Food and Drug Administration (FDA) for use under general anaesthesia. In one retrospective study,

1134 patients who received dexmedetomidine in the perioperative period were examined, and favourable results were reported.[34] Dexmedetomidine had been used both as an adjuvant[35] to regional anaesthesia, an intravenous addition to eliminate negative effects of intubation[36,37] in general anaesthesia, and as a method to provide controlled hypotension.

Jalonen and his colleagues had used dexmedetomidine as an anaesthetic adjuvant in open heart surgery in coronary artery grafting, and they found that the hyperdynamic response to surgery and anaesthesia was significantly suppressed in the dexmedetomidine group compared to the control group in an 80-patient study.[38] Guven et al.[11] investigated the effectiveness of dexmedetomidine on bleeding, haemodynamic parameters, and postoperative analgesia in their study that included over 40 patients scheduled for functional endoscopic sinus surgery in randomized, prospective, and control groups. No difference was found between pre- and postoperative haemoglobin values. However, they reported a significant difference in the bleeding score ($p = 0.019$). In our study, significant differences were found in HR as well as surgical area evaluation scale in the Group D compared to Group M.

In ESS, agents providing controlled hypotension and TIVA have emerged with the purpose of surgical field clarity. Therefore, we tested the superiority of two agents, magnesium and dexmedetomidine, against each other for this purpose.

This topic is a subject that is still of interest, and another intravenous agent, remifentanil, is also increasingly being used.[39] In the future, we believe that the number of effective and reliable drugs for ESS will continue to develop, but the interest will be clarified to concentrate on innovative methods.

The results obtained from our research have shown that dexmedetomidine provided better visual quality of the surgical field compared to magnesium when used in ESS patients under general anaesthesia. As a result, we believe that in endoscopic sinus surgeries, dexmedetomidine is a good alternative to magnesium due to its higher reducing effect on bleeding in the surgical field and the greater suppression of HR compared to magnesium.

Conflicts of interest

The authors declare no conflicts of interest.

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