MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.59218/makrjms.2023.401.405

BI-Spectral Index (BIS) Guided Comparison of Magnesium Sulphate and Dexmedetomidine as Anaesthetic Adjunct in Elective Cholecystectomy

[1]Debaleena Jana and [2]Sudipta Pal
[1]*Department of Anesthesiology, Midnapore Medical College*
[2]*Department of General Medicine, Bankura Sammilani Medical College*

ABSTRACT

Since the first clinical anesthesia demonstration in the 1840s, the level of anesthesia has changed continuously. Hypnotic (unconsciousness) and analgesic (pain reduction) elements can be used to characterize anaesthesia. The suppression of the clinical responses to unpleasant stimuli can be used to define the level of anesthesia. To compare the effects of Magnesium sulphate ($MgSO_4$) and Dexmedetomidine as adjuncts to anaesthetics in respect to anaesthetic consumption, intraoperative hemodynamics and postoperative recovery. This randomized, prospective, double-blinded trial was done in Bankura Sammilani Medical from January 2012 to June 2013. Seventy female patients of 20-60 years of age and ASA physical status I and II, undergoing elective open cholecystectomy were randomly allocated into two groups: magnesium sulphate (M) group and dexmedetomidine (D) group. Monitors were attached to the patients and baseline vital parameters (i.e., SBP, DBP, MAP, HR, SPO_2, temperature) were recorded. The depth of anaesthesia (DOA) was planned to be monitored with A-2000 BIS monitoring system, targeted at 40-60 forsurgical anaesthesia. The patients were randomly allocated into one of the 2 groups by opening sealed envelope. A bolus dose of $MgSO_4$ (30 mg kg^{-1} in 100 mL of 0.9% NS) in group M or a bolus dose of Dexmedetomidine (1 µg kg^{-1} in 100 mL of 0.9% NS) in group D was administered intravenously before induction over 10-15 min. Inj. $MgSO_4$ 1 g and inj. Dexmedetomidine 50 µg were diluted with 0.9% sodium chloride to form 50 ml solution and this infusion was initiated at rate of 0.5 mL kg^{-1} hr^{-1}, where the infusion dose were 10 and 0.5 µg kg^{-1} hr^{-1} for $MgSO_4$ and Dexmedetomidine respectively. In terms of age, body weight, height and length of operation, both groups were comparable. Both groups successfully maintained their intraoperative hemodynamic profiles, however group D did so better than group M in terms of HR, SBP, DBP and MAP. Both groups' hemodynamic profiles slightly improved in the post-intubation interval. In comparison to group M, group D experienced a substantial decrease in postoperative hemodynamic parameters for HR, SBP, DBP and MAP ($p<0.0001$). Propofol and sevoflurane consumption in group D was considerably lower than in group M ($p<0.0001$). Additionally, group D had considerably shorter induction and recovery times than group M ($p<0.0001$). In comparison to group M, group D's VAS score was significantly lower ($p<0.0001$). Dexmedetomidine, in comparison to magnesium sulphate, is a good anesthetic adjunct that reduces the need for anesthetics (propofol and sevoflurane) and analgesics (fentanyl), shortens the induction period and recovery period, attenuates sympathoadrenal responses, maintains stable hemodynamics and adequate depth of anesthesia and provides better postoperative analgesia and excellent recovery profiles.

OPEN ACCESS

Key Words
Anaesthesia, BIS, EEG, magnesium dexmedetomidine

Corresponding Author
Debaleena Jana,
Department of Anesthesiology, Midnapore Medical College

Received: 18 June 2023
Accepted: 25 June 2023
Published: 4 July 2023

Citation: Debaleena Jana and Sudipta Pal, 2023. BI-Spectral Index (BIS) Guided Comparison of Magnesium Sulphate and Dexmedetomidine as Anaesthetic Adjunct in Elective Cholecystectomy. Res. J. Med. Sci., 17: 401-405, doi: 10.59218/makrjms.2023.401.405

INTRODUCTION

Since the first clinical anesthesia demonstration in the 1840s, the level of anesthesia has changed continuously[1]. It is necessary to preserve normal hemodynamic parameters, unconsciousness, a quick and safe induction and a pain-free recovery. To achieve the clinical goals of hemodynamic control, lack of awareness and quick, safe induction and emergence, current clinical anesthesia involves carefully observing the clinical response to defined stimuli and then adjusting the hypnotic or analgesic dosage or both by using synergistic interaction[1].

It has been difficult to find the optimal monitor for measuring the degree of anesthesia. Reduced danger of consciousness, smoother hypnotic titration, decreased incidence of relative over- or under-dosing, quicker recovery and shorter hospital stay are some possible advantages of a monitor that permits the assessment of level of anesthesia[2]. The ability to choose anesthesia interventions rationally, including the use of hypnotics, analgesics and vasoactive medications, is crucial. Clinical indicators of anesthesia depth have historically included movements in reaction to surgical stimuli and vocal orders. Additionally, anaesthesiologists evaluate the level of anesthesia using cardiovascular and other autonomic reactions to pain.

In an effort to maintain an acceptable depth of anesthesia while also maintaining hemodynamic stability and the overall cost effectiveness of the surgery, adjuncts to anesthetics are now commonly employed.

This study compared the intake of anesthetic medications, perioperative hemodynamic changes, recovery time and postoperative duration of analgesia in two separate groups of participants using the adjuncts magnesium sulphate and dexmedetomidine.

Aims and objectives: To compare the effects of Magnesium sulphate ($MgSO_4$) and Dexmedetomidine as adjuncts to anaesthetics in respect to anaesthetic consumption, intraoperative hemodynamics and postoperative recovery.

MATERIALS AND METHODS

Study design: Double blind randomized prospective study.

Sample size: About 140 patients, 70 patients in each group.

Study technique: After getting the Institutional Ethics Committee clearance and the written informed consent from patients this study was carried out in Bankura Sammilani Medical College, Bankur from January 2012 to June 2013. Seventy female patients of 20- 60 years of age and ASA physical status I and II undergoing elective open cholecystectomy were randomly allocated into two groups: Magnesium sulphate (M) group and dexmedetomidine (D) group. Patients having body weight >80 kg, impaired hepatic and/or renal function, hypertension diabetes, neurological disorders, h/o allergy to anaesthetics/ study drugs, pregnant women, endocrine disorders and myopathy, patients treated with CCBs, beta blockers, anti-psychotics were excluded from this study.

On arrival to the operation room, monitors were attached to the patients and baseline vital parameters (i.e., SBP, DBP, MAP, HR, SPO2, temperature) were recorded. The depth of anaesthesia (DOA) was planned to be monitored with A-2000 BIS monitoring system, targeted at 40-60 for surgical anaesthesia.

The patients were randomly allocated into one of the 2 groups by opening sealed envelope. A bolus dose of $MgSO_4$ (30 mg kg^{-1} in 100 ml of 0.9% NS) in group M or a bolus dose of Dexmedetomidine (1 µg kg^{-1} in 100 mL of 0.9% NS) in group D was administered intravenously before induction over 10-15 min. Inj. MgSO4 1 gm and inj. Dexmedetomidine 50 µg were diluted with 0.9% sodium chloride to form 50 mL this infusion was initiated at rate of 0.5 mL kg^{-1} hr^{-1}, where the infusion dose were 10 mg and 0.5 µg kg^{-1} hr^{-1} for $MgSO_4$ and Dexmedetomidine respectively.

The patients were premedicated with inj. Glycopyrrolate 0.2 mg i.v, inj. Ondansetron 4 mg i.v and inj. Fentanyl 1 µg kg^{-1} i.v. After 3 minutes of preoxygenation anaesthesia was induced by inj. Propofoli.v. at the rate of 20 mg 5 $second^{-1}$ to achieve a BIS of 40-60. Facilitation of endotracheal intubation was done with inj. Vecuronium 0.12 mg kg^{-1} i.v. Maintenance of anaesthesia was done with O2:N2O (40%:60%), inj. Vecuronium (0.01 mg kg^{-1} i.v intermittent bolus) and with inhalation of Sevoflurane in the volume percentage of 0.6%-1.8% .Sevoflurane was titrated to maintain BIS in the range of 40-60and Vecuronium was titrated to maintain TOF ratio of 0.6 with neuromascular monitor. In the BIS range of 40-60, the signs of inadequate analgesia, i.e., increased HR and MAP of >20% of baseline were managed by i.v. bolus dose of inj. Fentanyl 0.5 µg kg^{-1}. The patients were mechanically ventilated in volume cycle controlled mode ventilation to maintain $EtCO_2$ between 30-35 mm Hg. Throughout the surgery normothermia was properly maintained.

At the end of the operation, the respective infusion was stopped. Time to reach BIS value 80 was recorded. All the patients were reversed by appropriate doses of Neostigmine and Glycopyrrolate. The hemodynamic parameters were monitored during pre-induction (after bolus dose ofstudy anaesthetic adjuncts) and post induction period, post intubation and after surgicalincision and thereafter at 5th, 15th and 30th min and then at every 30 min interval till the end of operation andafter extubation. Peroperative End tidal Sevoflurane concentrations were also recorded at regular intervals. Recovery time was

assessed by using the time required to respond to verbal commands (spontaneous eye opening) and orientation time (to recollect name, address). Post operatively, each patient was kept under observation for at least 4 hrs in the PACU and all the vital parameters were noted along with assessment of pain by using VAS immediately, after 30 min, 2nd hr and 4th hr. Rescue analgesic in the form of inj. Diclofenac sodium 75 mg i.m was given if VAS>3. Drug related side effects and any adverse events were also noted during perioperative period.

RESULTS AND DISCUSSIONS

Our study was designed to compare the effects of intravenous dexmedetomidine with magnesium sulphate as anaesthetic adjuncts in patients undergoing elective open cholecystectomy. From the results of our study it was established that as adjunct to anaesthetics dexmedetomidine significantly reduced anaesthetic consumption, shortened induction and recovery period, maintained better perioperative hemodynamic profiles and provided better postoperative analgesia compared to magnesium sulphate (Table 1).

In the study of Mansou[3] BIS-guided evaluation of dexmedetomidine vs midazolam as anaesthetic adjuncts in off-pump coronary artery bypass surgery, patients in group D (Dexmedetomidine group) received dexmedetomidine as an initial IV loading dose of 1 g kg^{-1} before induction of anaesthesia.

Prior to induction, patients in group M received a bolus of $MgSO_4$ at a dosage of 30 mg kg^{-1} in 100 mL NS over 10-15 min. Kaur and Baghla[4] in their study, the trial of IV $MgSO_4$ for post-operative analgesia in upper limb orthopaedic surgery under GA employed $MgSO_4$ 30 mg kg^{-1} as a bolus before induction in magnesium sulphate group (group M) participants (Table 2).

Dexmedetomidine 50 g was diluted in 50 mL of NS and an infusion of 0.5 g kg^{-1} hr^{-1} was begun in group D and maintained until the completion of operation. Unlike our investigation, Mansou[3] published his findings, the maintenance dosage was dexmedetomidine 1 kg^{-1} hr^{-1} and the infusion was produced in a 50 mL syringe containing 300 g dexmedetomidine and infused using a syringe pump at a rate of 10 mL hr^{-1}.

Table 1: Comparison of propofol and sevoflurane consumption between two groups given as means (SD)

Anesthetic Consumption	Group D	Group M	p-value
Propofol (mg)	76.74 (4.06)	95.09 (3.48)	0.0001
Sevoflurane (%)	0.84 (0.04)	1.15 (0.05)	0.0001

Table 2: Induction period and recovery period in different groups given as mean (SD)

Time period	Group D	Group M	p-value
Induction period (sec) BIS <60	50.09 (4.15)	60.06 (3.49)	0.0001
Recovery period (min) BIS >80	4.78 (0.43)	7.76 (1.02)	0.0001

In our trial, after receiving a bolus dose of $MgSO_4$, patients in group M received an intraoperative infusion of 10 mg kg^{-1} hr^{-1}. The chosen dosage resulted in considerable intra- and post-operative analgesia with no bouts of severe hypotension or bradycardia. The work of Kaur *et al*.[4] backs up this conclusion. Ray M and colleagues utilized $MgSO_4$ 10 mg kg^{-1} hr^{-1} as a bolus dosage in their investigation as well. Unlike the study of Elsharnouby[5] $MgSO_4$ 40 mg kg^{-1} over 15 min before induction and 15 mg kg^{-1} hr^{-1} via continuous infusion intraoperatively was employed in the trial and there were more episodes of severe hypotension and bradycardia. As a result of using a lower dosage of $MgSO_4$, there were no occurrences of hypotension or bradycardia in our trial.

We found that 1 g kg^{-1} fentanyl was enough to give analgesia while keeping the hemodynamic profile and BIS stable during the surgical operation. Both groups did not require any further fentanyl doses. Ray M and colleagues discovered in 2010 that groups C (clonidine) and M ($MgSO_4$) had much reduced fentanyl requirements than group P (placebo). Godhki[6] and colleagues administered fentanyl at a dosage of 1.5 g kg^{-1} and found that it was sufficient to give analgesia until the time of pneumoperitonium. During the pneumoperitonium, however, 30% of patients required fentanyl top-up.

The propofol need was substantially lower (25-33%) in group D than in group M ($p<0.001$). Godhki *et al*.[6], with a bolus of dexmedetomidine 1 g kg^{-1} and a maintenance infusion of dexmedetomidine 0.2 g kg^{-1} hr^{-1}, the induction dosage of propofol was reduced by 62.5%.

Dexmedetomidine also significantly decreased the consumption of sevoflurane (30-35%) compared to $MgSO_4$ ($p<0.001$) to maintain BIS values between 40-60 intraoperative. Fragen and Fitzgerald[7] in a research published in 1999 titled 'Effect of dexmedetomidine on the Minimum alveolar concentration (MAC) of Sevoflurane in adults aged 55-70 years' discovered that a plasma concentration of 0.7 ng mL^{-1} of dexmedetomidine had a 17% MAC decreasing effect on sevoflurane.

The intraoperative hemodynamic parameters (HR, SBP, DBP and MAP) of both groups from the beginning to the completion of the procedure. HR, SBP, DBP and MAP are the descriptive statistics for intraoperative hemodynamic parameters.

We can see that both groups' hemodynamic parameters (HR, SBP, DBP and MAP) were well maintained during the intraoperative time, however group D was better maintained than group M. On the other hand, during post-intubation period, there was slight increase in HR (D-105.06±4.586, M-84.54±2.693), SBP (D-118.07±7.53, M-107.6±7.25), DBP (D-93.25±2.65, M 70.86±3.90) and MAP (D-104.40±5.727, M-110.37±2.335) in both the groups.

Hemodynamic parameters (HR, SBP, DBP and MAP) were measured at 0 hr (immediately following extubation), 1, 2 and 4 hr postoperatively. The descriptive statistics of postoperative hemodynamic measures (HR, SBP, DBP and MAP). It demonstrates that there was a statistically significant reduction in hemodynamic measures such as HR, SBP, DBP and MAP during the postoperative period in group D compared to group M (p<0.0001).

In this study, we employed Dexmedetomidine and $MgSO_4$ as anaesthetic adjuncts to maintain a better hemodynamic condition during the peri-operative period, which helped us achieve one of our key goals. Mansou[3] discovered that dexmedetomidine anaesthesia induced a substantial and prolonged drop in HR, resulting in improved cardiac outcomes for patients having vascular surgery due to tight heart rate control. He saw that all other hemodynamic variables remained stable. As a result, he discovered that dexmedetomidine was an effective anesthetic adjunct for patients having OPCAB surgery.

Dexmedetomidine was shown to be more effective than $MgSO_4$ in reducing sympathetic reactions to intubation, skin incision and extubation. Godhki *et al*.[6] Dexmedetomidine was reported to sustain satisfactory perioperative hemodynamic stability. They also discovered that dexmedetomidine significantly reduces the vasopressor response to laryngoscopy and intubation, as well as the sympathoadrenal reaction associated with pneumoperitoneum.

Comparison of the induction and recovery periods in 2 groups. We discovered that the dexmedetomidine group had a considerably shorter induction duration (BIS<60) and recovery period (BIS>80) than the $MgSO_4$ group (p<0.0001) (Table 2).

After comparing the clonidine and $MgSO_4$ groups to the control group in terms of induction and recovery time, Altan *et al*.[8] also At the conclusion of anaesthesia, the recovery time for BIS to reach 80 was considerably shorter in the clonidine group compared to the $MgSO_4$ and control groups (p<0.0001) (Table 3).

Recovery times for two groups are compared. In our investigation, recovery time was measured using three parameters: Extubation time, time for verbal reaction to verbal instruction and time for orientation, comparable to Bhattacharjee *et al*.[9] experimentswhen the characteristics of recovery were examined across groups, we discovered that group M took substantially longer than group D (p<0.0001). This occurrence might be attributed to magnesium sulphate's central nervous system depression.

Similarly, Bhattacharjee *et al*.[9] the $MgSO_4$ group had longer recovery time metrics than the clonidine and control groups. 'The effects of magnesium sulphate and clonidine on propofol consumption, hemodynamics and postoperative recovery'.

VAS scores at 0, 1, 2 and 4 hrs were compared between two groups. Figure No highlighted that the VAS score, i.e., postoperative analgesia, was better sustained in group D than in group M, with the exception of the initial postoperative period, i.e., at 0 hr (Table 4).

Due to α2-receptor mediated regulation of nociception at the level of the spinal noradrenergic system, dexmedetomidine lowers analgesic demand in the intraoperative and postoperative period. There is considerable evidence that 2-receptors in the spinal cord's dorsal horn neurons may produce endogenous opiate molecules[10].

Magnesium acts as an antagonist at NMDA receptors in the CNS, this proposed mechanism underlying Magnesium's antinociceptive effect includes calcium ion influx inhibition, antagonism of NMDA receptors and prevention of central sensitization after peripheral tissue injury or inflammation due to inhibition of dorsal horn NMDA receptor.

We discovered that no rescue analgesic was necessary in any of the groups since VAS never surpassed three (>3) in any of the patients until 4 hs after surgery.

Table 3: Comparison of recovery time following discontinuation of study anaesthetic drugs infusion between two groups given as mean (SD)

Time period	Group D	Group M	p-value
Extubation time (min)	5.03 (0.82)	8.14 (0.77)	0.0001
Verbal communication (min)	7.43 (0.85)	9.53 (1.14)	0.0001
Orientation time (min)	8.90 (0.72)	10.52 (0.88)	0.0001

Table 4: Comparison of postoperative analgesia in the form of VAS score given as mean (SD)

Pain scale	Group D	Group M
VAS 0	1.20±0.406	1.26±0.443
VAS 1	1.14±0.355	1.00±000
VAS 2	1.17±0.382	1.11±0.323
VAS 4	1.26±0.443	1.00±0.000

Table: 5 Intraoperative hemodynamic parameters

	HR (min)			SBP (mm Hg)		
Time	D	M	p-value	D	M	p-value
BL	94.30±3.525	110.20±3.08	0.5201	129.46±3.381	130.91±3.914	0.1503
PRIND	64.58±2.34	105. 90±4.0	0.0001	115.80±3.939	125.31±3.471	0.0015
POIND	75.23±5.37	74.91±3.543	0.0002	95.06±3.447	116.49±3.013	0.0009
POINT	105.06±4.586	84.54±2.693	0.0702	118.07±7.53	107.60±7.25	0.0001
AFSI	72.27±1.110	81.01±1.212	0.0001	220.16±1.202	222.27±1.067	0.0001
2 min	62.11±1.272	72.01±1.826	0.0001	222.10±1.282	228.16±2.270	0.0001
12min	72.01±1.122	72.20±1.612	0.7210	222.86±1.121	226.81±2.081	0.0001
10 min	71.01±1.122	71.16±1.662	0.2200	220.20±1.027	221.60±1.107	0.0011
60 min	81.72±1.212	71.71±1.226	0.0002	227.20±1.121	222.02±1.212	0.0002

Godhki *et al*.[6] found in his study, Dexmedetomidine as an anesthetic adjuvant in laparoscopic surgery: An observational research employing entropy monitoring was the title of their study, which discovered that the intraoperative and postoperative periods required fewer opioids.

Mentes *et al*.[11] and Ferasatkish R and colleagues [12]observed the effectiveness of magnesium sulphate in lowering postoperative pain after laparoscopic coronary bypass grafting and cholecystectomy, respectively. The results of our investigation supported those from the earlier studies.

Knowing that magnesium sulphate amplifies the effects of non-depolarizing muscle relaxants, we decided against using a neuromascular monitor in our investigation. Nevertheless, none of the study group's patients had neuromascular blockage that had been prolonged. This was the second study constraint.

Consequently, we draw the conclusion from the current study that magnesium sulphate and dexmedetomidine were both effective additives to anesthetics. In contrast to magnesium sulphate, dexmedetomidine more effectively achieved the goals and objectives of reducing anaesthetic and analgesic consumption, maintaining hemodynamic profile during the perioperative period, reducing induction and recovery times and providing good postoperative analgesia and a good recovery profile (Table 5).

CONCLUSION

Our intension was to observe the effects of dexmedetomidine and magnesium sulphate as an anaesthetic adjunct while maintaining the adequate anaesthetic depth (BIS 40-60). On the basis of the present study we found that both dexmedetomidine and magnesium sulphate were useful adjuncts to anaesthesia for patients undergoing elective open cholecystectomy. However, we observed that in comparision to magnesium sulphate, dexmedetomidine is a better anaesthetic adjunct that decreases the requirement of anaesthetics (propofol and sevoflurane) and analgesics (fentanyl), shortens induction period and recovery period, attenuates sympathoadrenal responses, maintains the stable hemodynamics and adequate depth of anaesthesia and provides better postoperative analgesia and excellent recovery profile.

REFERENCES

1. Gelb, A.W., K. Leslie, D.R. Stanski and S.L. Shafer, 2010. Monitoring the Depth of Anesthesia. In: Miller's Anesthesia., Gelb, A.W., K. Leslie, D.R. Stanski and S.L. Shafer, (Eds.)., Elsevier, ISBN-13: 9780443069598, pp: 1229-1265.
2. Rosow, C. and P.J. Manberg, 2001. Bispectral index monitoring. Anesthesiol. Clin. North Am., 19: 947-966.
3. Mansour, E.D., 2009. Bis-guided evaluation of dexmedetomidine vs. midazolam as anaesthetic adjuncts in off-pump coronary artery bypass surgery (OPCAB). Saudi J. Anaesth., 3: 7-14.
4. Kaur, S. and N. Baghla, 2012. Evaluation of intravenous magnesium sulphate for postoperative analgesia in upper limb orthopaedic surgery under general Anaesthesia: A comparative study. Inter. J. Anesthesiol., Vol. 30.
5. Elsharnouby, N.M. and M.M. Elsharnouby, 2006. Magnesium sulphate as a technique of hypotensive anaesthesia. Br. J. Anaesth., 96: 727-731.
6. Ghodki, P., S. Thombre, S. Sardesai and K. Harnagle, 2012. Dexmedetomidine as an anesthetic adjuvant in laparoscopic surgery: An observational study using entropy monitoring. J. Anaesthesiol. Clin. Pharmacol., 28: 334-338.
7. Fragen, R.J. and P.C. Fitzgerald 1999. Effect of dexmedetomidine on the minimum alveolar concentration (MAC) of sevoflurane in adults age 55 to 70 years. J .Clin. Anesth., 11: 466-467.
8. Altan N. Turgut, F. Yildiz, A. Türkmen and H. Ustün, 2005. Effects of magnesium sulphate and clonidine on propofol consumption, haemodynamics and postoperative recovery. Br. J. Anaesth., 94: 438-441.
9. Bhattacharjee, D., B. Hajra, R. Pal, N. Chatterjee and M. Ray, 2010. Effect of clonidine and magnesium sulphate on anaesthetic consumption, haemodynamics and postoperative recovery: compar Anaesth., 54: 137-141.
10. Fleetwood-Walker, S.M., R. Mitchell, P.J. Hope, V. Molony and A. Iggo, 1985. Selective inhibition by noradrenaline of nociceptive responses of identified dorsal horn neurones. Brain Res, 334: 243-254.
11. Mentes, O., A. Harlak, T. Yigit, A. Balkan and M. Balkan *et al*., 2008. Effect of intraoperative magnesium sulphate infusion on pain relief after laparoscopic cholecystectomy. Acta Anaesthesiologica Scand., 52: 1353-1359
12. Ferasatkish, R., A. Dabbagh Alavi, G. Mollasadeghi and E. Hydarpur *et al*., 2008. Effect of magnesium sulfate on extubation time and acute pain in coronary artery bypass surgery. Acta Anaesthesiologica Scand., 52: 1348-1352.