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Comparing the Effect of Bolus Intravenous Dexmedetomidine Vs Magnesium Sulphate on Onset of Atracurium using a Tof Monitor-A Randomised Controlled Trial

Dr. Harshanaa. G[1], Dr. Anand S [2], Dr Hanford Bernnon[3]

[1] Post Graduate , Department of Anaesthesiology , Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education , Kelambakkam , Chennai.

[2] Professor , Department of Anaesthesiology , Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education , Kelambakkam , Chennai.

[3] Assistant Professor , Department of Anaesthesiology , Chettinad Hospital and Research Institute, Chettinad Academy of Research and Education , Kelambakkam , Chennai

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KEYWORDS

Anaesthesia, Dexmedetomidine, Hemodynamic Stability, Magnesium Sulphate, Randomized Controlled Trial, Sedation.

ABSTRACT:

Background: Anaesthesia plays a pivotal role in modern surgical procedures by ensuring patient safety, comfort, and optimal surgical conditions. Neuromuscular blockade is an essential component for facilitating muscle relaxation during surgery. Adjunctive agents like Dexmedetomidine and Magnesium sulphate are increasingly used to enhance neuromuscular blockade and improve perioperative hemodynamic stability.

Aim: The primary aim of this study was to compare the effects of bolus intravenous Dexmedetomidine versus Magnesium sulphate on neuromuscular blockade during general anaesthesia. The study specifically evaluated their influence on the onset and recovery of neuromuscular blockade.

Methods: This prospective, randomized controlled trial included 75 adult patients undergoing elective surgeries under general anaesthesia. Participants were divided into three groups: Group A (Dexmedetomidine), Group B (Magnesium sulphate), and Group C (Normal Saline). The onset and recovery of neuromuscular blockade was monitored using the train-of-four (TOF) technique, and hemodynamic parameters (heart rate, blood pressure, mean arterial pressure) were recorded before and after intubation.

Results: Group B (Magnesium sulphate) demonstrated the fastest onset of neuromuscular blockade (mean time: 3 min 19 sec), while Group A (Dexmedetomidine) showed a faster recovery (mean time: 47 min 16 sec).

Findings: Dexmedetomidine was found to be superior in providing hemodynamic stability while Magnesium sulphate, however, facilitated a quicker onset of blockade and may be beneficial in scenarios requiring rapid muscle relaxation and longer duration of blockade.

INTRODUCTION

Anaesthesia is a cornerstone of modern surgery, ensuring that patients remain unconscious and pain-free while maintaining essential physiological functions during the procedure.[1] One of the key components of anaesthesia is neuromuscular blockade (NMB), which involves the administration of non-depolarizing neuromuscular blocking agents (NMBAs).[2] These agents induce skeletal muscle relaxation by blocking the transmission of nerve impulses at the neuromuscular junction. Such muscle relaxation is crucial during surgeries that require muscle paralysis for optimal access and manipulation of internal organs.[3,4]

Journal of Chemical Health Risks

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The efficacy of neuromuscular blockade can be measured and monitored using tools like the train-of-four (TOF) ratio, which involves delivering four electrical stimuli to a peripheral nerve and observing the response of the associated muscle.[5] The TOF ratio is used to gauge the depth of neuromuscular blockade and to ensure that adequate muscle relaxation is achieved while preventing residual paralysis, which could lead to complications like postoperative respiratory difficulties or aspiration.[6,7]

While NMBAs are effective, their use needs to be carefully managed, especially when considering the onset and recovery times.[8] The onset time refers to the time taken for the TOF ratio to decrease from 4 to 0, signifying the complete block of neuromuscular transmission. Recovery from neuromuscular blockade, on the other hand, is measured by the time taken for the TOF value to return from 0 to 1, indicating the return of partial neuromuscular function.[9,10]

One challenge in anaesthesia practice is balancing the onset and recovery of neuromuscular blockade while ensuring the patient's hemodynamic stability.[11] High doses of anaesthetic agents can lead to hemodynamic instability, including hypotension and bradycardia, particularly in patients with underlying cardiovascular issues. To mitigate these adverse effects, adjunctive agents like Dexmedetomidine and Magnesium sulphate are often used.[12,13]

Dexmedetomidine is a highly selective alpha-2 adrenergic agonist that has gained popularity in anaesthesia due to its sedative, analgesic, and anxiolytic properties, without causing significant respiratory depression.[14] It acts centrally on the alpha-2 receptors in the brainstem, leading to a reduction in sympathetic outflow, resulting in sedation and a decrease in heart rate and blood pressure.[15] This mechanism makes Dexmedetomidine useful in providing hemodynamic stability during anaesthesia induction and maintenance.[16]

Magnesium sulphate, a cation which is a calcium channel blocker and NMDA receptor antagonist has been explored for its potential in enhancing neuromuscular blockade.[17] By inhibiting calcium influx at the neuromuscular junction, magnesium sulphate potentiates the effects of NMBAs, resulting in enhanced muscle relaxation. It is widely used in clinical practice for its analgesic and neuromuscular blocking properties, particularly in perioperative settings.

Although both Dexmedetomidine and Magnesium sulphate are commonly used as adjuncts in anaesthesia, there is limited research comparing their direct effects on neuromuscular blockade in a randomized controlled trial (RCT) setting.[18] This study aims to fill that gap by comparing the effects of bolus intravenous Dexmedetomidine and Magnesium sulphate on the onset and recovery of neuromuscular blockade, as measured by TOF monitoring, in patients undergoing elective surgeries under general anaesthesia.

AIM & OBJECTIVES:

To compare the effects of bolus intravenous Dexmedetomidine and Magnesium sulphate on neuromuscular blockade during general anaesthesia, with a specific focus on:

- The time required for TOF values to change from 4 to 0.
- The time taken for TOF values to return to 1 after induction.

MATERIALS AND METHODS

The study included 75 patients who were scheduled for elective surgeries. The inclusion criteria included patients aged between 18 and 60 years, classified as ASA Class I and II, and who provided informed consent. The exclusion criteria included ASA Class III or higher, pregnancy, known or anticipated difficult airway, emergency surgeries, patients with significant cardiovascular diseases (e.g., heart block, bradycardia), a BMI greater than 30 kg/m², and patients on beta-blockers or with a history of hypotension.

Patients were randomly assigned to one of three groups using computer-generated randomization. Group A received bolus intravenous Dexmedetomidine (0.5 mcg/kg), Group B received bolus intravenous Magnesium sulphate (50 mg/kg), and Group C (control group) received Normal saline.

Before the induction of anaesthesia, a detailed preoperative assessment was performed, which included a thorough medical history, physical examination, and baseline laboratory investigations. Baseline hemodynamic parameters such as heart rate, blood pressure, saturation and respiratory rate were recorded. The patients were fasted for at least six hours before the

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(3), 1237-1243 | ISSN:2251-6727

procedure, and an 18-gauge intravenous cannula was inserted for drug administration.

The study drug solution of either Dexmedetomidine or $MgSO_4$ or Normal saline (control) will be prepared in 100 ml normal saline by an independent consultant not involved in this study; the investigator will also remain blind regarding the constituents of the solution. The drug bolus will be given over 10 minutes.

After drug infusion, vitals will be noted.Inj Fentanyl 2mcg/kg will be given. Inj Propofol 2mg/kg will be given. Vitals such as Heart rate, BP, Saturation will be noted.Inhalational agent -Sevoflurane 2% will be used. Inj Atracurium 0.5mg/kg will be given and TOF monitor connected. The duration taken for TOF to change from 4 to 0 is noted.

After TOF monitor value changes from 4 to 0 laryngoscopy and intubation will be performed.Vitals noted post intubation. Controlled ventilation will be maintained with Sevoflurane 2% and a mixture of air and oxygen.

Time taken for the recovery from 1st dose of Atracurium after intubating dose is noted using a TOF monitor. The time taken for TOF value to change from 0 to 1 will be noted.

At the end of surgery, reversal of neuromuscular block will be done by using i.v Neostigmine 0.05mg/kg and Inj.Glycopyrrolate 0.02mg/kg and extubated.

The data collected from the study included demographic details (age, sex, BMI, ASA classification), hemodynamic parameters (heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure), and neuromuscular recovery times (TOF values).Statistical analysis was performed using SPSS software (version 25). Continuous variables were expressed as mean ± standard deviation, and categorical variables were presented as percentages. Inter-group comparisons were made using one-way analysis of variance (ANOVA) for continuous variables and Chi-square tests for categorical data. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 75 patients were included in the study, with 25 patients in each of the three groups: Group A (dexmedetomidine), Group B (magnesium sulphate), and Group C (control-Normal saline).

Table 1: Age Distribution

Age Group	Group A (Dexmedetomidine)	Group B (Magnesium Sulphate)	Group C (Control)
<30 years	2 (8%)	8 (32%)	6 (24%)
31–45 years	14 (56%)	11 (44%)	9 (36%)
46–60 years	9 (36%)	5 (20%)	6 (24%)
>60 years	0 (0%)	1 (4%)	4 (16%)
Total	25 (100%)	25 (100%)	25 (100%)

Interpretation:
The majority of patients in all groups were between 31 and 45 years. Group A (Dexmedetomidine) had the highest percentage of patients in this age range (56%), while Group B (Magnesium Sulphate) had the highest percentage of younger patients (<30 years), and Group C (Control) had the highest percentage of older patients (>60 years). The p-value of 0.079 indicates that age distribution differences among the groups were not statistically significant.

Journal of Chemical Health Risks
www.jchr.org
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Table 2: Sex Distribution

Sex	Group A (Dexmedetomidine)	Group B (Magnesium Sulfate)	Group C (Control)
Female	16 (64%)	17 (68%)	12 (48%)
Male	9 (36%)	8 (32%)	13 (52%)
Total	25 (100%)	25 (100%)	25 (100%)

Interpretation:
Females constituted a larger proportion of cases in all groups, with Group B (Magnesium Sulphate) having the highest percentage of females (68%). The p-value of 0.072 suggests no statistically significant differences in sex distribution among the groups.

Table 3: Mean TOF Change from 4 to 0 (Onset Time)

Group	Mean Time (Minutes)	Standard Deviation (SD)	p-value
Group A (Dexmedetomidine)	4 min 30 sec	0 min 15 sec	0.000
Group B (Magnesium Sulphate)	3 min 19 sec	0 min 10 sec	
Group C (Control)	4 min 7 sec	0 min 12 sec	

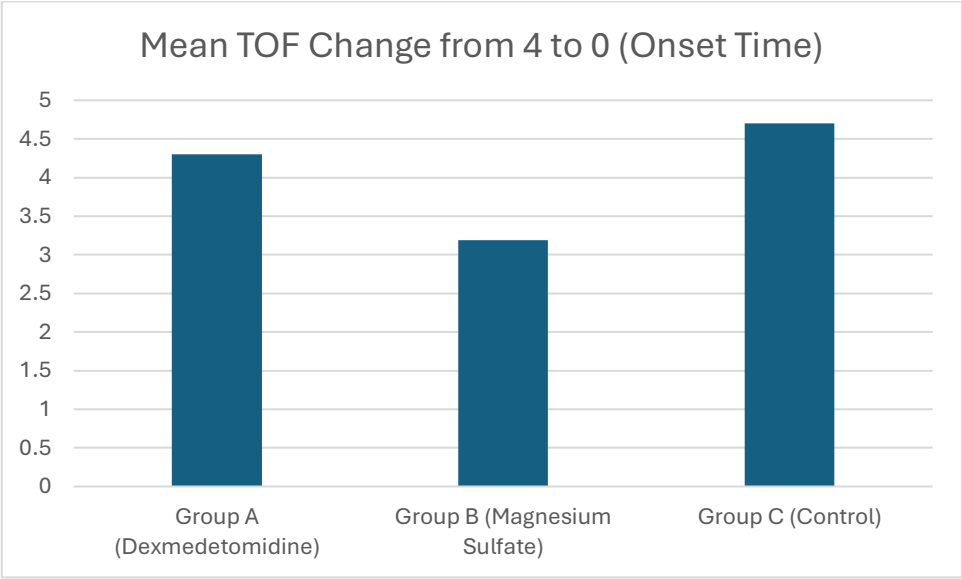

Figure 1 : Mean TOF Change from 4 to 0 (Onset Time)

Interpretation:
Group B (Magnesium Sulphate) demonstrated the fastest onset of neuromuscular blockade (3 min 19 sec), followed by both Group A (Dexmedetomidine) and Group C (Control), which had mean times of 4 min 30 sec and 4 min 7 sec respectively. The p-value of 0.000 indicates a statistically significant difference in onset times.

Journal of Chemical Health Risks
www.jchr.org
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Table 4: Mean TOF Change from 0 to 1 (Recovery Time)

Group	Mean Time (Minutes)	Standard Deviation (SD)	p-value
Group A (Dexmedetomidine)	47 min 16 sec	9 min 19 sec	0.000
Group B (Magnesium Sulphate)	57 min 52 sec	5 min 45 sec	
Group C (Control)	40 min 1 sec	7 min 30 sec	

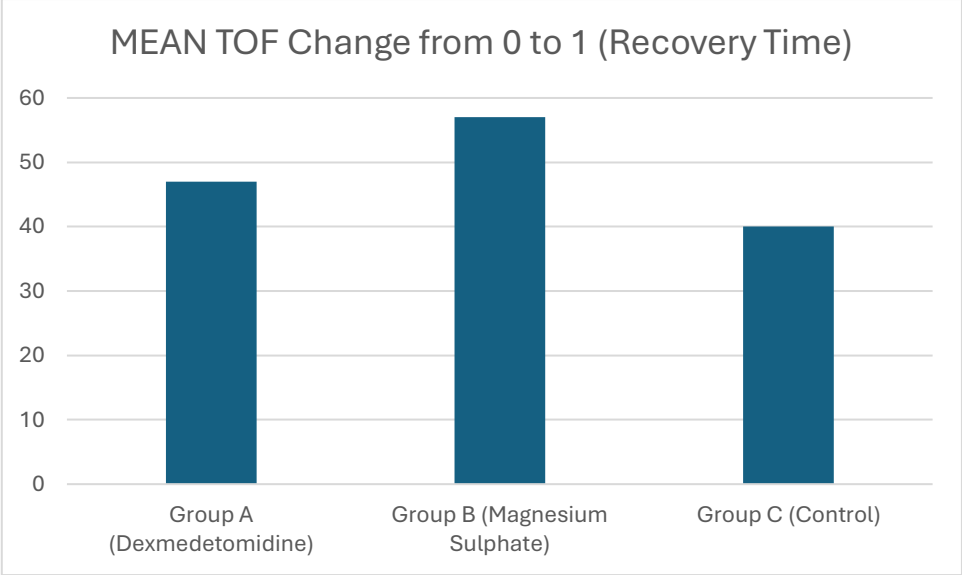

Figure 2 : Mean TOF Change from 0 to 1 (Recovery Time)

Interpretation:
Group A (Dexmedetomidine) exhibited the quickest recovery from neuromuscular blockade (47 min 16 sec), followed by Group B (Magnesium Sulphate) (57 min 52 sec), and Group C (Control) (40 min 1 sec). The p-value of 0.000 suggests statistically significant differences in recovery times, with dexmedetomidine providing faster recovery.

DISCUSSION

The purpose of this study was to compare the effects of bolus intravenous Dexmedetomidine and Magnesium sulphate on neuromuscular blockade during general anaesthesia. Specifically, we focused on the time taken for the train-of-four (TOF) ratio to change from 4 to 0 (onset of neuromuscular blockade) and from 0 to 1. The present study's results suggest that both agents have distinct effects on the onset and recovery of neuromuscular blockade, with Dexmedetomidine providing faster recovery and magnesium sulphate facilitating faster onset.

ONSET OF NEUROMUSCULAR BLOCKADE (TOF 4 TO 0)

The results from Table 4 clearly show that magnesium sulphate (Group B) produced a faster onset of neuromuscular blockade compared to both Dexmedetomidine (Group A) and the control group (Group C). Magnesium sulphate's mean time for the TOF ratio to change from 4 to 0 was 3 min 19 sec, significantly shorter than the 4 min 30 sec observed in Group A (Dexmedetomidine).[20,21] The control group, which did not receive either of the adjuvant drugs, exhibited a similar onset time of 4 min 7 sec. The faster onset in the Magnesium sulphate group can be attributed to its mechanism of action as an NMDA receptor antagonist

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and calcium channel blocker. By inhibiting calcium influx at the neuromuscular junction, Magnesium sulphate potentiates the effects of non-depolarizing neuromuscular blocking agents, thereby leading to a quicker blockade.

The statistical significance (p-value of 0.000) of these results confirms that Magnesium sulphate is more effective than dexmedetomidine in accelerating the onset of neuromuscular blockade, making it particularly useful in procedures where rapid muscle relaxation is required.

RECOVERY FROM NEUROMUSCULAR BLOCKADE (TOF 0 TO 1)

The recovery from neuromuscular blockade, measured by the time taken for the TOF ratio to return from 0 to 1, was significantly faster in the Dexmedetomidine group (Group A) compared to the Magnesium sulphate group (Group B). Group A had a mean recovery time of 47 min 16 sec, whereas Group B took 57 min 52 sec for the TOF ratio to reach 1. The control group had the fastest recovery. This rapid recovery in the control group is expected as no adjuvant drugs were administered, and the neuromuscular blockade naturally wore off faster.[22,23]

Dexmedetomidine, being an alpha-2 adrenergic agonist, acts centrally to reduce sympathetic outflow and provide hemodynamic stability. These properties can lead to improved recovery from neuromuscular blockade, potentially by enhancing the clearance of the muscle relaxant agents and promoting faster muscle function restoration.[24] The p-value of 0.000 indicates that the differences between the groups in recovery times are statistically significant, supporting the conclusion that dexmedetomidine facilitates a quicker recovery compared to Magnesium sulphate.

CLINICAL IMPLICATIONS

The findings of this study have important clinical implications. Magnesium sulphate's faster onset of neuromuscular blockade makes it an ideal agent for surgeries requiring rapid muscle relaxation, such as in cases of rapid sequence intubation or when muscle paralysis is essential early in the procedure.[25,26] On the other hand, dexmedetomidine's faster recovery from neuromuscular blockade suggests that it may be more beneficial for surgeries where rapid emergence from anaesthesia is critical, such as outpatient surgeries or in patients with underlying cardiovascular conditions who require hemodynamic stability.[27]

LIMITATIONS AND FUTURE RESEARCH

While this study provides useful insights into the comparative effects of dexmedetomidine and magnesium sulphate, there are some limitations to consider. First, the study only focused on two adjuvant drugs, and future research could explore additional agents or combinations that might further optimize neuromuscular blockade and recovery. Second, the sample size, while appropriate for this trial, could be expanded in future studies to include a more diverse patient population and assess the generalizability of the findings.

Future research should also investigate the long-term outcomes of using these agents, such as postoperative recovery time, pain management, and patient satisfaction. Additionally, the impact of these agents on different types of surgeries and anaesthesia protocols warrants further exploration.

CONCLUSION

Both Dexmedetomidine and Magnesium sulphate have distinct roles in modulating neuromuscular blockade. Magnesium sulphate is more effective for inducing a faster onset of neuromuscular blockade, while Dexmedetomidine facilitates quicker recovery from blockade. Furthermore, Dexmedetomidine provides better control over hemodynamic responses during intubation, making it a suitable option for patients requiring hemodynamic stability. These findings contribute valuable insights to the field of anaesthesiology and suggest that both agents have clinical utility depending on the specific surgical and patient needs.

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Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(3), 1237-1243 | ISSN:2251-6727

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