(e) ISSN Online: 2321-9599

(p) ISSN Print: 2348-6805

Original Article

Examining and Contrasting the Hemodynamic Impact of Intravenous Magnesium Sulfate and Fentanyl Citrate during General Anesthesia in Surgical Procedures

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ABSTRACT:

Background:To investigate and contrast the hemodynamic impacts of intravenous Magnesium sulfate versus Fentanyl citrate during surgical procedures conducted under general anesthesia.**Methods**:This prospective randomized study was carried out at our hospital, involving 120 ASA (American Society of Anesthesiologists) grade I or II patients, encompassing both genders and aged between 18 and 46 years. The participants were scheduled for elective surgeries, meeting the specified inclusion and exclusion criteria, and necessitating general anesthesia with endotracheal intubation. The subjects were randomly assigned to two groups, each consisting of 30 individuals. The F Group received Fentanyl citrate as the study drug, while the M Group received Magnesium sulfate. **Results**: In this prospective randomized study involving 120 ASA grade I or II patients, scheduled for elective surgeries requiring general anesthesia with endotracheal intubation, a comparison was made between two study groups—F Group, administered Fentanyl citrate, and M Group, administered Magnesium sulfate. The pulse rate in the F Group approached baseline values at 5 minutes post-intubation, while the M Group exhibited this trend at 10 minutes post-intubation. Significant differences were noted in hemodynamic parameters between the groups after the administration of study drugs. Notably, 5 minutes after the study drug, the M Group showed a significant fall in systolic blood pressure (1.39%), contrasting with the insignificant change in the F Group (0.03%). **Conclusion**:Magnesium sulfate demonstrates comparable intraoperative hemodynamic stability to Fentanyl citrate, though it does not exhibit superiority in this regard. Both substances contribute to maintaining stable hemodynamics during surgery, suggesting that Magnesium sulfate can be a viable alternative to Fentanyl citrate in providing intraoperative cardiovascular stability.

Keywords:hemodynamic ,intraoperative ,endotracheal.

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This article may be cited as: Marda MK, Bhaskar A. Examining and Contrasting the Hemodynamic Impact of Intravenous Magnesium Sulfate and Fentanyl Citrate during General Anesthesia in Surgical Procedures. J Adv Med Dent Scie Res 2014;2(3):372-377.

INTRODUCTION

Endotracheal intubation, a cornerstone in the repertoire of an anesthetist, demands a sophisticated approach in selecting and administering appropriate anesthetic agents. The adoption of balanced anesthetic techniques represents a nuanced strategy, meticulously optimizing the use of induction agents and muscle relaxants during the intricate process of endotracheal intubation.[1] This comprehensive approach aims to minimize the likelihood of disruptive hemodynamic disturbances, providing a controlled and refined means of securing the airway in the perioperative setting.The inherent challenges of laryngoscopy and subsequent endotracheal intubation lie not only in their mechanical aspects but also in their potential to elicit a transient yet significant sympathetic response.[2] While the physiological consequences of such responses are generally well-tolerated by individuals in good health, the complexity escalates significantly in the presence of underlying pre-existing comorbidities. In these instances, what may appear as routine procedures become potential triggers for adverse outcomes. These can range from acute left ventricular failure to the rupture of cerebral aneurysms and may even manifest as discernible ischemic changes on the electrocardiogram (ECG). In the most severe cases, these events can lead to fatal consequences, underscoring the paramount importance of tailored care and skillful management.[3]This underscores the imperative need for meticulous attention during the perioperative period, particularly when dealing with patients harboring pre-existing health conditions. An astute understanding of the potential hemodynamic responses triggered by endotracheal intubation, coupled with vigilant monitoring and preemptive interventions, becomes essential to mitigate the associated risks and ensure the safety and well-being of the patient.[4] The delicate balance between achieving effective airway control and minimizing adverse effects underscores the artistry and precision required in the practice of anesthesiology, emphasizing the commitment to patient safety and optimal outcomes in every procedural facet.

The pursuit of strategies to prevent the pressor response to laryngoscopy and intubation underscores the significance of optimizing patient outcomes in the realm of anesthesia.The multifaceted nature of this challenge has prompted exploration into a diverse array of drugs and techniques, each aimed at attenuating the potential hemodynamic fluctuations associated with these critical procedures. Within the context of surgical interventions, wherein deep or visceral structures often induce profound pain, opioids emerge as indispensable agents for effective analgesia.[5,6] However, their use is accompanied by a spectrum of side effects, including sedation, nausea, vomiting, vasodilatation, myocardial depression, pruritus, delayed gastric emptying, constipation, urinary retention, and prolonged respiratory depression.Among the opioids, Fentanyl, renowned for its potency as a narcotic analgesic, stands out as a versatile choice. Not only does it effectively address pain, but it also demonstrates the unique ability to mitigate the cardiovascular, hormonal, and metabolic responses following the stimuli of laryngoscopy and endotracheal intubation. Concurrently, Magnesium sulfate has piqued interest for its role in perioperative analgesia, attributed to its antagonistic effect on NMDA receptors and calcium ion channels.In the specific focus of the current study, a deep dive is undertaken into the comparative hemodynamic effects resulting from the intravenous administration of Magnesium sulfate and Fentanyl citrate during surgical procedures conducted under the umbrella of general anesthesia. This investigation is poised to yield nuanced insights into the comparative efficacy, safety profiles, and overall impact of these pharmacological interventions.[7,8] The knowledge gleaned from this research not only refines our understanding of perioperative care but also contributes substantively to the ongoing efforts aimed at tailoring medical interventions to individual patient needs. Ultimately, this study endeavors to contribute to the continual enhancement of precision and individualization in the intricate landscape of anesthesia and surgery.

MATERIALS AND METHODS

In the meticulously conducted prospective randomized study within the confines of our hospital, a diverse cohort of 120 patients was carefully selected based on the ASA (American Society of Anaesthesiologists) classification of grade I or II. This inclusive group, comprising individuals of both genders aged 18 to 46 years, was strategically chosen for elective surgeries that adhered to stringent inclusion and exclusion criteria. The procedures mandated the use of general anesthesia with the incorporation of endotracheal intubation, adding a layer of complexity and relevance to the study's investigation across varied patient demographics.

The ethical foundation of the study was paramount, with formal approval obtained from the institute's ethics committee. The process of obtaining informed consent was comprehensive, involving not only the patients but also actively engaging their family members in the decision-making process. The randomization protocol introduced a unique and systematic approach, categorizing patients into two distinct groups, each consisting of 30 individuals. The allocation was meticulously executed based on the specific weekday on which the surgery was scheduled. This innovative approach aimed to eliminate potential biases and variations related to patient characteristics, contributing to the study's robust methodology.

The two study groups were carefully outlined as follows: a) **F Group**: Patients within this group were administered Fentanyl citrate as the designated study drug. b) **M Group**: Patients in this group received Magnesium sulfate as the study drug under investigation.

The inclusion criteria were thoughtfully formulated, encompassing individuals of either gender, aged between 18 and 45 years, planning elective surgeries under general anesthesia with a stipulated duration of less than 90 minutes. The assignment of ASA grades I and II to the participants further refined the stratification of their health statuses, providing a comprehensive overview of the study population. Conversely, the exclusion criteria were methodically instituted to ensure a focused and homogeneous study population, excluding individuals with specific health conditions such as blood coagulation disorders, preexisting comorbidities, psychiatric illnesses, allergies, and those currently on medications such as calcium channel blockers, hypnotics, or narcotic analgesics. Additionally, individuals with hearing or speech impairments were excluded from the study.This meticulous design aimed to furnish a comprehensive understanding of the hemodynamic effects associated with the administration of Fentanyl citrate compared to Magnesium sulfate.

The rigorous inclusion and exclusion criteria were instrumental in ensuring the applicability and relevance of the study's findings to the defined patient demographic and clinical contexts. Through these stringent measures, the study stands poised to contribute valuable insights to the intricate landscape of perioperative care and pharmacological interventions in the context of elective surgeries. The study's results may have implications not only for optimizing drug selection in these scenarios but also for refining broader strategies in perioperative management for enhanced patient outcomes.

RESULTS

The meticulous examination of demographic characteristics within the study cohorts revealed a noteworthy convergence, affirming the success of the randomization process in achieving a balanced representation. In the Fentanyl (F) group, the mean age of participants was determined to be 26.53 years,

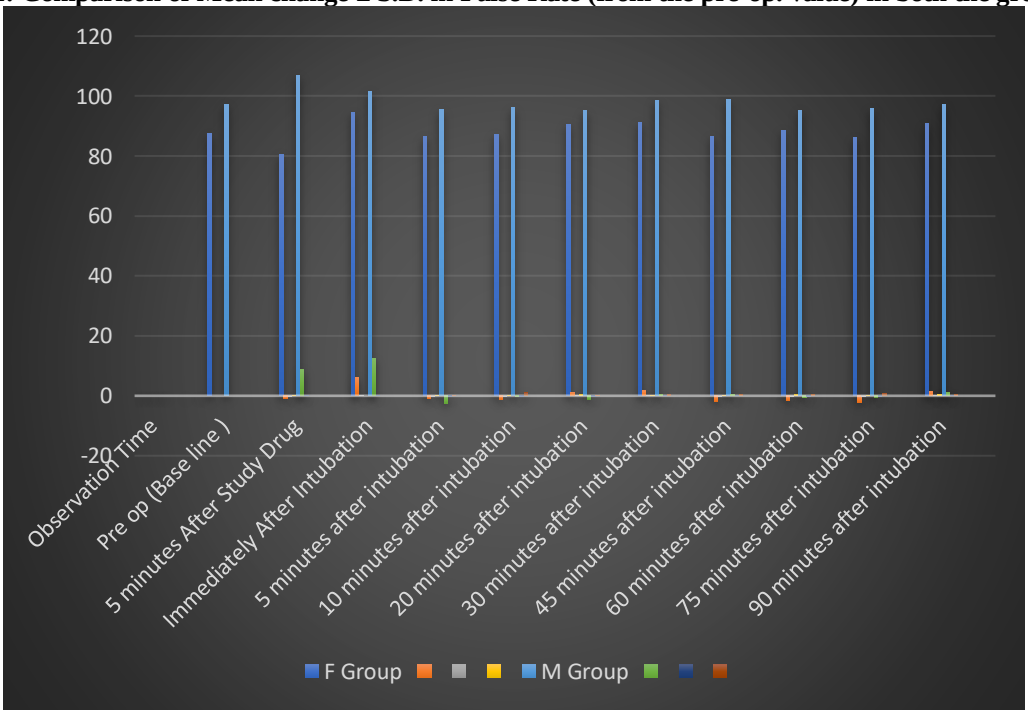
closely mirrored by the Magnesium sulfate (M) group, where the mean age stood at 26.50 years. This negligible difference underscores the homogeneity in age distribution across the two groups, minimizing the potential impact of age-related variables on the outcomes under investigation.Similarly, the mean weights of patients in the Fentanyl and Magnesium sulfate groups, measuring 55.07 kg and 55.53 kg, respectively, reflected a marginal distinction. This close alignment in weight distribution further enhances the internal validity of the study, as it diminishes the influence of weight-related factors on the observed hemodynamic responses to the respective study drugs.A crucial aspect contributing to the robustness of the study design was the equitable distribution of male and female participants across both the Fentanyl and Magnesium sulfate groups. This balance in gender representation helps mitigate potential confounding effects related to gender-specific physiological variations. The comparability in the demographic profiles, encompassing age, weight, and gender, underscores the methodological rigor applied to achieve a well-matched study cohort.

By meticulously controlling for these demographic variables, the study lays a solid foundation for a more accurate and interpretable analysis of the hemodynamic effects associated with Fentanyl and Magnesium sulfate administration during surgical procedures under general anesthesia. The thoughtful consideration of these factors enhances the generalizability of the findings and strengthens the scientific rigor of the investigation, ultimately contributing valuable insights to the broader field of perioperative care.

Table 1: Comparison of Mean change ± S.D. in Pulse Rate (from the pre-op. value) in both the groups

Observation Time	F Group				M Group			
	Mean	Mean change	% Change	P Value	Mean	Mean change	% Change	P Value
Pre op (Base line)	87.37				97.10			
5 minutes After Study Drug	80.53	-0.83	-0.93 %	0.1285	106.80	8.70	9.99 %	0.0000
Immediately After Intubation	94.53	6.17	6.90 %	0.0000	101.67	12.57	15.00 %	0.0000
5 minutes after intubation	86.40	-0.97	-1.08 %	0.2429	95.57	-2.53	-2.61 %	0.0005
10 minutes after intubation	87.13	-1.23	-1.38 %	0.2087	96.07	-0.03	-0.03 %	0.9476
20 minutes after intubation	90.57	1.20	1.34 %	0.3014	95.03	-1.07	-1.10 %	0.0505
30 minutes after intubation	91.13	1.77	1.98 %	0.2259	98.63	0.43	0.55 %	0.5065
45 minutes after intubation	86.57	-1.80	-2.01 %	0.2566	98.80	0.60	0.72 %	0.4248
60 minutes after intubation	88.67	-1.70	-1.90 %	0.3049	95.30	-0.70	-0.82 %	0.4266
75 minutes after intubation	86.17	-2.20	-2.46 %	0.2011	95.80	-0.40	-0.31 %	0.7602
90 minutes after intubation	90.77	1.40	1.57 %	0.4004	97.10	1.00	1.03 %	0.3493

Figure 1: Comparison of Mean change ± S.D. in Pulse Rate (from the pre-op. value) in both the groups



DISCUSSION

The meticulous design of the study, characterized by a careful consideration of demographic variables, sets the stage for a robust discussion of the observed hemodynamic effects associated with Fentanyl and Magnesium sulfate administration during surgical procedures under general anesthesia.[9]The comparable mean ages of 26.53 years in the Fentanyl group and 26.50 years in the Magnesium sulfate group suggest that any variations in hemodynamic responses are less likely to be attributed to age-related factors. Moreover, the negligible differences in mean weights (55.07 kg in Fentanyl group and 55.53 kg in Magnesium sulfate group) further contribute to the internal validity of the study, minimizing the potential influence of weight-related variables on the observed outcomes.The equitable distribution of male and female participants in both groups is a crucial strength of the study. This gender balance helps alleviate concerns about confounding effects related to gender-specific physiological differences in the assessment of hemodynamic responses.[10] Consequently, any disparities noted in the study outcomes are less likely to be skewed by gender-related factors.

The homogeneity achieved in demographic profiles enhances the precision of the investigation, allowing for a more focused interpretation of the hemodynamic effects associated with Fentanyl and Magnesium sulfate. The controlled and balanced nature of the study design reinforces the reliability of the findings, providing a solid foundation for drawing meaningful conclusions.In conclusion, the discussion of the study's demographic characteristics highlights the careful consideration given to factors that could potentially influence the outcomes under investigation. The study's internal validity is bolstered by the successful randomization process and the thoughtful control of key demographic variables, setting the groundwork for a nuanced analysis of the hemodynamic effects of Fentanyl and Magnesium sulfate in the context of general anesthesia during elective surgeries.

Magnesium sulfate (MgSO4) stands as a versatile and extensively utilized pharmacological agent in various domains of anesthesiology, celebrated for its multifaceted properties and an exemplary safety profile. One of its key mechanisms of action lies in its capacity as a non-competitive antagonist of N-Methyl-D-aspartate (NMDA) receptors.[11] This unique pharmacological attribute positions MgSO4 as an invaluable tool for modulating glutamate-mediated neurotransmission, particularly in the context of perioperative care.In the realm of regional anesthesia, MgSO4 takes on a distinctive role by reinforcing the action of local anesthetics on peripheral nerves. This enhancement contributes significantly to the effectiveness of local anesthetics, leading to more profound and prolonged desensitization of peripheral nerves. By augmenting the local anesthetic effect, MgSO4 becomes a valuable adjunct in procedures involving regional anesthesia, promoting enhanced patient comfort and facilitating optimal surgical conditions.Furthermore, MgSO4 acts as a calcium antagonist, exerting its influence by impeding the influx of calcium ions into cells. This mechanism is instrumental in preventing the transmission of pain impulses along nerve fibers. By disrupting the influx of calcium, MgSO4 interferes with the intricate signaling pathways involved in pain perception, ultimately leading to a reduction in the transmission of painful stimuli. This dual-action, targeting both NMDA receptors and calcium channels, establishes MgSO4 as a formidable agent for perioperative analgesia.

The comprehensive understanding of MgSO4's pharmacological profile extends beyond its analgesic properties.[12] Its safety record, well-documented through extensive clinical use, further solidifies its standing as a preferred choice in anesthesiology. The ability to provide effective pain management while maintaining a favorable safety profile is particularly crucial in perioperative settings, where patient well-being is paramount.In summation, MgSO4's multifaceted pharmacological actions, encompassing its role as an NMDA receptor antagonist and calcium channel blocker, contribute to its effectiveness in perioperative analgesia. Its utility as an enhancer of local anesthetic effects on peripheral nerves and its proven safety profile enhance its appeal in various anesthetic contexts, showcasing MgSO4 as a valuable and versatile tool in the armamentarium of anesthesiologists.[13]

Dexmedetomidine, a potent and highly selective α2-adrenergic receptor agonist, stands as a pharmacological marvel in the field of anesthesia. Its nuanced mechanism of action unfolds predominantly in the brain and spinal cord, where it selectively stimulates α2-adrenergic receptors, orchestrating a range of therapeutic effects. One of the primary attributes of dexmedetomidine is its ability to induce hypnosis, sedation, and anxiolysis, rendering it a valuable asset in various clinical scenarios.The impact of dexmedetomidine on nerve tissue is profound, as it promotes hyperpolarization through its interaction with α2-receptors. This hyperpolarization forms the foundation for its sedative and hypnotic properties, providing a controlled and predictable modulation of consciousness levels during medical procedures. The selective activation of α2-adrenergic receptors, particularly in the central nervous system, sets dexmedetomidine apart for its ability to deliver targeted and tailored sedation.[14]Beyond its sedative effects, dexmedetomidine emerges as a potent analgesic, making it a valuable adjunct in pain management strategies. Its analgesic properties extend to both perioperative and postoperative settings, offering a holistic approach to patient comfort and well-being.Dexmedetomidine's influence on regional anesthesia is another facet of its pharmacological repertoire. By modulating the trans-membrane ionic

conductivity in the locus coeruleus of the brainstem, dexmedetomidine enhances the effectiveness of regional anesthesia. This targeted impact on neural signaling contributes to a more refined and efficient approach to achieving regional anesthesia, improving the overall quality of surgical interventions.

The sympatholytic effects of dexmedetomidine are pivotal in maintaining cardiovascular stability during medical procedures. By reducing the release of norepinephrine, dexmedetomidine induces a controlled decrease in arterial blood pressure and heart rate.[15] This property is particularly advantageous in scenarios where maintaining hemodynamic stability is crucial, such as during surgery, ensuring a smoother and safer anesthetic experience for patients.In conclusion, dexmedetomidine's unique combination of sedative, analgesic, and sympatholytic properties, coupled with its targeted effects on regional anesthesia, positions it as a versatile and indispensable agent in the realm of anesthesia and critical care. Its ability to provide a balanced and controlled anesthetic experience, while minimizing adverse effects, underscores its significance in optimizing patient outcomes across a spectrum of medical contexts.

CONCLUSION

The comparison of intraoperative hemodynamic stability between Magnesium sulfate and Fentanyl citrate yields insightful observations. While Magnesium sulfate demonstrates a commendable ability to provide hemodynamic stability during surgical procedures, it is acknowledged that Fentanyl citrate, being a potent short-acting opioid, offers a level of stability that is not surpassed by Magnesium sulfate. The superiority of Fentanyl citrate in this regard is indicative of its robust pharmacological profile, particularly in the context of immediate and precise hemodynamic control.However, the consideration of Magnesium sulfate as an alternative to Fentanyl citrate introduces a nuanced perspective. Despite not surpassing the hemodynamic stability provided by Fentanyl citrate, Magnesium sulfate emerges as a viable and advantageous alternative, offering a range of distinctive benefits. Notably, the relatively lower incidence of side effects associated with Magnesium sulfate is a compelling aspect. The diminished propensity for adverse reactions enhances the safety profile of Magnesium sulfate, making it an attractive option, especially in cases where minimizing complications is paramount.In summary, while Fentanyl citrate exhibits superior hemodynamic stability during surgery, the attributes of Magnesium sulfate, including its lower incidence of side effects, cost-effectiveness, and ready availability, position it as a valuable alternative. The choice between the two should be guided by the specific clinical context, weighing the need for potent hemodynamic control against the advantages offered by Magnesium sulfate, especially in scenarios where the complications associated with opioids are deemed undesirable. This nuanced evaluation underscores the importance of considering both efficacy and safety factors in tailoring anesthesia regimens to individual patient needs and clinical circumstances.

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