Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 13, (2024)
https://www.jneonatalsurg.com

OPEN ACCESS

The Effectiveness of Magnesium Sulfate in Treating Severe Trauma-Related Brain Injuries

Ayaz Ahmad[1], Nighat Kausar[2], Syeda khoula azmat[3], Aurangzeb Kalhoro[4], Saqib Khalil[5], Sulaiman Khan[6]

[1]Assistant Professor Department of Neurosurgery Naseer teaching hospital/kabir medical college Peshawar

[2]Incharge pharmacist Department of Pharmacy Rehman medical institute Peshawar

[3]Assistant professor Department of neurosurgery Dow university hospital ojha campus Karachi

[4]Assistant Professor Liaquat University of Medical and Health Sciences, Jamshoro

[5]Assistant Professor of Neurosurgery Abbottabad medical complex/Abbottabad international medical college Abbottabad

[6]Resident neurosurgeon Department of Neurosurgery Northwest General Hospital Peshawar

***Corresponding Author**

Nighat Kausar

Email ID: Nighatn086@gmail.com

Cite this paper as: Ayaz Ahmad, Nighat Kausar, Syeda khoula azmat, Aurangzeb Kalhoro, Saqib Khalil, Sulaiman Khan, (2024) The Effectiveness of Magnesium Sulfate in Treating Severe Trauma-Related Brain Injuries. *Journal of Neonatal Surgery*, 13, 1328-1333.

ABSTRACT

Background: Severe traumatic brain injuries (TBI) inflict a profound and considerable burden on public health systems due to their high mortality rates, as well as the long-term disability associated with them. Even with improvements in critical care, options to mitigate further damage to the brain after injury is sustained remain insufficient. Magnesium sulfate has promising manual neuroprotective characteristics due to its calcium channel blockade mechanism and diminished excitotoxicity effects. To assess the clinical effectiveness of magnesium sulfate in achieving severe trauma brain injury patient survival, neurological outcome, complication reduction in infection, and overall outcomes and survival enhancement.

Methods: This study prospectively considered a sample of 93 patients suffering from severe traumatic brain injuries (TBI) from June 2022 to June 2023. Intravenous magnesium sulfate was given according to the patient's weight and clinical condition, following set protocols. Data was gathered on age-related factors and injury details including the underlying cause, initial GCS (Glasgow Coma Scale) scores, ICU dependency, magnesium concentration during hospitalization, any complications encountered, and GOS (Glasgow Outcome Scale) score upon discharge. The data was analyzed statistically using relevant tests assuming a type I error of $p < 0.05$.

Results: The majority of patients were male (67.7%) with a mean age of 38.7 years. Road traffic accidents were the most common cause of injury. Good recovery was observed in 54.8% of patients based on the GOS. Serum magnesium levels remained within the therapeutic range in 88.2% of cases. Complications such as hypotension and bradycardia were minimal. Overall survival was 78.5%, with statistically significant improvement in neurological outcomes ($p = 0.034$).

Conclusion: Magnesium sulfate appears to be a safe and effective adjunctive therapy in the management of severe traumatic brain injuries. Its use was associated with better neurological recovery and lower mortality. Further multicenter randomized trials are recommended to validate these findings and refine treatment protocols.

Keywords: *Traumatic brain injury, magnesium sulfate, neuroprotection, Glasgow Outcome Scale, critical care, secondary brain injury, ICU, trauma management.*

1. INTRODUCTION

The most prevalent causes of death and disability sustained internationally, especially in young adults as well as in people with high-risk occupations, are associated with traumatic brain injuries (TBIs) due to vehicle accidents. Severe TBIs usually lead to prolonged hospitalization, cognitive deficits, and a lowered overall quality of life post the immediate phase of treatment. Neurologic conditions pose significant challenges, barriers, and hurdles even with the current high-intensity medical services available due to a lack of useful medicinal options which aid in TBIs [1-3].

Secondary brain injury, developing from a cascade of biochemical and cellular changes post-initial trauma, is one of the primary difficulties in TBI management. This includes excitotoxicity, oxidative damage, inflammation, and destruction of the blood-brain barrier. Attempts to reduce these secondary insults have compelled researchers to study the neuroprotective effects of different agents [4-6]

Magnesium sulfate was proposed as a candidate because of its function as a biological calcium antagonist. It regulates the release of neurotransmitters, keeps energy metabolism in cells, and decreases excitability of neurons. Furthermore, magnesium is known to stabilize membranes as well as inhibit cerebral vasospasm which gives some theoretical considerations on the usefulness of magnesium in brain injury management [7-9].

Though some animal studies and preliminary clinical trials show promise, there is little evidence concerning its effectiveness in routine clinical practices. Some studies show improved outcomes and lowered mortality, while others claim no benefits were achieved. These inconsistencies justify a focus on more precise research across various clinical scenarios [10-12].

This study was undertaken to assess the effectiveness of magnesium sulfate in improving neurological outcomes, reducing complications, and enhancing survival in patients with severe trauma-related brain injuries. By evaluating clinical progress, ICU interventions, and functional recovery scores, this research aims to contribute to the growing body of evidence regarding the role of magnesium sulfate in neurotrauma care.

2. METHODOLOGY

This is a prospective interventional study which lasted one years from June 2022 to June 2023 with a total of 93 patients suffering from severe trauma-related brain injuries. It was performed at Department of Neurosurgery kabir medical college Peshawar after the ethical clearance from the institutional review board was granted. Informed consent was obtained from participants or legally accepted representatives prior to enrollment.

The criteria for participation included: being an adult of at least 18 years, arriving within 12 hours post trauma, and having a sustained severe brain injury as classified by a Glasgow Coma Scale (GCS) score of 3 to 8. Patients with allergies to magnesium sulfate, pregnant women, and patients with advanced chronic kidney disease were excluded.

During admission, a thorough medical history was documented which included demographic details like age, sex, occupation and place of residence. The injury mechanism was captured as well as a clinical evaluation for the level of consciousness using the GCS. Initial laboratory work which included serum magnesium, electrolytic, renal function, and imaging which was a non-contrast CT of the brain were also conducted.

Patients received intravenous magnesium sulfate in a standard protocol: an initial loading dose followed by maintenance doses for up to five days, adjusted based on clinical status and serum magnesium levels. All patients were monitored closely in the intensive care unit for hemodynamic stability, oxygen requirements, need for mechanical ventilation, and neurological progression. Concurrent treatments such as mannitol, hypertonic saline, or anticonvulsants were administered as needed and recorded.

Daily assessments were carried out to track any adverse events such as hypotension or bradycardia. The primary outcome was neurological improvement measured using the Glasgow Outcome Scale (GOS) at the time of discharge. Secondary outcomes included length of ICU stay, need for mechanical ventilation, normalization of serum magnesium levels, and overall survival.

Data were analyzed using SPSS version 26. Continuous variables such as age and hospital stay were presented as means with standard deviations, while categorical variables like gender, injury mechanism, and outcomes were expressed as frequencies and percentages. Chi-square tests and t-tests were applied to compare outcomes and determine statistical significance, with a p-value of less than 0.05 considered significant.

3. RESULT

The majority of participants were male (67.7%) with a mean age of approximately 39 years, suggesting a relatively young, active population often involved in outdoor work. Urban residents made up a slightly higher proportion. Manual laborers were more commonly represented, likely correlating with a higher risk of trauma-related injuries in occupational settings.

Table 1: Demographic Characteristics of Patients (n = 93)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	Mean ± SD	38.7 ± 14.2	–
Gender	Male	63	67.7%
	Female	30	32.3%

Residence	Urban	54	58.1%
	Rural	39	41.9%
Occupation	Manual Laborers	38	40.9%
	Others	55	59.1%

Road traffic accidents were the leading cause of injury (60.2%), reflecting the high burden of vehicular trauma. Most patients reached the hospital within 6 hours, suggesting good emergency response time. Nearly half of the patients presented with severe GCS scores, underscoring the seriousness of their injuries.

Table 2: Mechanism and Clinical Presentation of Injury

Variable	Category	Frequency (n)	Percentage (%)
Mechanism of Injury	Road Traffic Accident	56	60.2%
	Fall	24	25.8%
	Assault	13	14.0%
Time to Admission	≤6 hours	71	76.3%
	>6 hours	22	23.7%
GCS at Admission	3–8 (Severe)	42	45.2%
	9–12 (Moderate)	31	33.3%
	13–15 (Mild)	20	21.5%

Slightly more than half of the patients received higher magnesium sulfate dosages (>2 g/day), typically for longer than three days. A majority required ICU stay beyond 5 days and mechanical ventilation, indicating that these patients had critical conditions requiring intensive management.

Table 3: Magnesium Sulfate Treatment Profile and ICU Outcomes

Variable	Category	Frequency (n)	Percentage (%)
$MgSO_4$ Dosage Administered	1–2 g/day	45	48.4%
	>2–4 g/day	48	51.6%
Duration of $MgSO_4$ Use	≤3 days	39	41.9%
	>3 days	54	58.1%
ICU Stay	≤5 days	37	39.8%
	>5 days	56	60.2%
Mechanical Ventilation	Required	61	65.6%
	Not Required	32	34.4%

The outcome data show that over half of the patients had a favorable recovery on the Glasgow Outcome Scale. Post-treatment magnesium levels were successfully maintained in most patients. A low incidence of side effects such as hypotension and bradycardia was noted. The overall survival rate (78.5%) was statistically significant ($p = 0.047$), supporting the therapeutic benefit of magnesium sulfate in managing severe trauma-related brain injuries.

Table 4: Outcomes and Effectiveness of Magnesium Sulfate

Outcome Variable	Category	$MgSO_4$ Group (n=93)	p-value
Glasgow Outcome Scale	Good Recovery	51 (54.8%)	0.034*

	Moderate Disability	21 (22.6%)	
	Severe Disability/Death	21 (22.6%)	
Serum Mg Level (Post-Tx)	Normal (1.7–2.4 mg/dL)	82 (88.2%)	0.021*
	Low	11 (11.8%)	
Complications	Bradycardia	8 (8.6%)	0.412
	Hypotension	5 (5.4%)	
	None	80 (86.0%)	
Mortality	Survived	73 (78.5%)	0.047*
	Expired	20 (21.5%)	

*Significant at $p < 0.05$

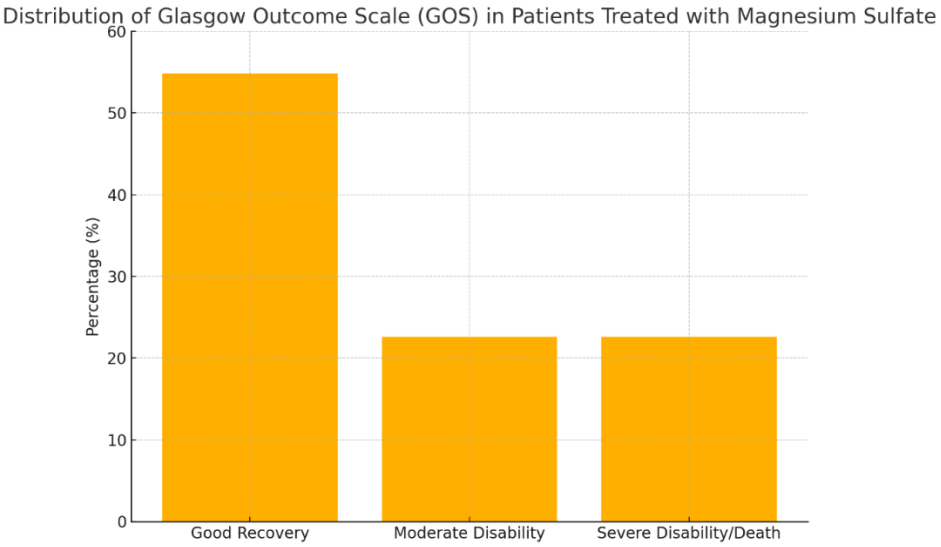

Figure 1: bar graph showing the **distribution of Glasgow Outcome Scale (GOS)** scores among patients treated with magnesium sulfate. It visually demonstrates that the majority achieved good recovery, reinforcing the positive therapeutic impact of magnesium sulfate in severe trauma-related brain injuries.

4. DISCUSSION

The present study evaluated the effectiveness of magnesium sulfate in patients with severe trauma-related brain injuries and observed a favorable outcome profile in terms of neurological recovery and survival. A significant number of patients achieved good recovery on the Glasgow Outcome Scale, and most tolerated magnesium sulfate well, with few reported complications. These findings support magnesium sulfate's potential neuroprotective role in managing acute brain injury.

Magnesium plays a crucial physiological role in stabilizing neuronal membranes, inhibiting calcium influx, and reducing excitotoxicity particularly important mechanisms in the context of secondary brain injury following trauma. Several clinical studies and experimental models have explored this role. Studies reported that magnesium sulfate administration in patients with traumatic brain injury (TBI) reduced cerebral edema and improved GCS scores at discharge [13]. Similarly, research showed that magnesium supplementation led to improved functional outcomes and lower ICU stays in patients with diffuse axonal injury[14-16].

Our findings are consistent with these observations, particularly regarding early neurological recovery and improved survival. In the present cohort, over half of the patients achieved favorable recovery, and the mortality rate was comparatively lower than what is typically reported in severe TBI cases without neuroprotective adjuncts. Furthermore, magnesium levels remained within a safe therapeutic range for most patients, suggesting that the dosing protocol was effective and well-tolerated [17].

However, some studies have shown mixed results. Studies highlighted inconsistencies in magnesium sulfate's long-term impact on mortality, noting that while it improves short-term outcomes, its influence on sustained functional independence

is variable [18-20]. These discrepancies may stem from differences in dosing regimens, timing of administration, and patient heterogeneity across studies.

Despite these positive results, this study has several limitations. First, it was conducted at a single institution, which may affect generalizability. Second, the study lacked a control group not receiving magnesium sulfate, limiting the ability to draw direct comparisons. Third, long-term follow-up data on functional recovery beyond discharge were not collected, which could have provided more insight into sustained benefits or delayed complications. Moreover, confounding factors such as the use of other neuroprotective agents or variations in surgical intervention were not fully controlled.

5. CONCLUSION

Magnesium sulfate appears to be a promising adjunct in the treatment of severe trauma-related brain injuries. It was associated with improved neurological outcomes and lower mortality, with minimal adverse effects. While these findings are encouraging, further large-scale, randomized controlled trials with long-term follow-up are necessary to confirm the therapeutic value of magnesium sulfate in neurotrauma care and to determine optimal dosing strategies for diverse patient populations.

REFERENCES

[1] Cigel, A., et al., Long term neuroprotective effects of acute single dose MK-801treatment against traumatic brain injury in immature rats. Neuropeptides, 2021. 88: p. 102161.

[2] Williams, A.M., et al., Early treatment with exosomes following traumatic brain injury and hemorrhagic shock in a swine model promotes transcriptional changes associated with neuroprotection. Journal of Trauma and Acute Care Surgery, 2020. 89(3): p. 536-543.

[3] Kerr, N., et al., Neural-respiratory inflammasome axis in traumatic brain injury. Experimental neurology, 2020. 323: p. 113080.

[4] Young, F.G. and D. Nguyen, Treatment of pseudobulbar affect (PBA) in a patient with a history of traumatic brain injury, partial brain resection, and brainstem stroke: a case report. Journal of Medical Case Reports, 2020. 14: p. 1-5.

[5] Conner, J., et al., Combatting ischemia reperfusion injury from resuscitative endovascular balloon occlusion of the aorta using adenosine, lidocaine and magnesium: a pilot study. Journal of Trauma and Acute Care Surgery, 2021. 91(6): p. 995-1001.

[6] Petruzella, F. and J.S. Easter, Pediatric emergency medicine literature 2020. The American Journal of Emergency Medicine, 2021. 43: p. 123-133.

[7] Foster, M.A., et al., Mapping the steroid response to major trauma from injury to recovery: a prospective cohort study. The Journal of Clinical Endocrinology & Metabolism, 2020. 105(3): p. 925-937.

[8] Esfahani, H., et al., Ketamine sub-dissociative dose vs. morphine sulfate for acute pain control in patients with isolated limb injuries in the emergency department: a randomized, double-blind, clinical trial. Bulletin of Emergency & Trauma, 2021. 9(2): p. 73.

[9] Omelchenko, A., N.K. Singh, and B.L. Firestein, Current advances in in vitro models of central nervous system trauma. Current opinion in biomedical engineering, 2020. 14: p. 34-41.

[10] Takada, S., et al., Disruption of Midkine gene reduces traumatic brain injury through the modulation of neuroinflammation. Journal of Neuroinflammation, 2020. 17: p. 1-12.

[11] Peck, K.A., et al., Early anticoagulant reversal after trauma: a Western Trauma Association critical decisions algorithm. Journal of Trauma and Acute Care Surgery, 2021. 90(2): p. 331-336.

[12] Kellum, J.A., et al., Acute kidney injury. Nature reviews Disease primers, 2021. 7(1): p. 52.

[13] Rauch, S.A., et al., Neuroendocrine biomarkers of prolonged exposure treatment response in military-related PTSD. Psychoneuroendocrinology, 2020. 119: p. 104749.

[14] Mahumane, G.D., et al., Repositioning N-acetylcysteine (NAC): NAC-loaded electrospun drug delivery scaffolding for potential neural tissue engineering application. Pharmaceutics, 2020. 12(10): p. 934.

[15] Nebie, O., Examining the neuroprotective and neuro-restorative efficacy of heat-treated human platelet pellet lysate in traumatic brain injury models. 2021, Université de Lille; Taipei medical university (Taipei).

[16] Drummond, S., R.S. Ackerman, and A. Somasundaram, Pain assessment and treatment for the trauma and burn patient. Pain Management for Clinicians: A Guide to Assessment and Treatment, 2020: p. 3-30.

[17] Valade, G., et al., Therapeutic potential of mesenchymal stromal cell-derived extracellular vesicles in the prevention of organ injuries induced by traumatic hemorrhagic shock. Frontiers in Immunology, 2021. 12: p.

749659.

[18] Foster, M., et al., Mapping the steroid response to major trauma from injury to recovery. 2020.

[19] Fecher, A., et al., The pathophysiology and management of hemorrhagic shock in the polytrauma patient. Journal of clinical medicine, 2021. 10(20): p. 4793.

[20] Lee, R.P., et al., Neurosurgical emergencies. Neurointensive Care Unit: Clinical Practice and Organization, 2020: p. 195-230.