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Original Article

Navigating Complex Spinal Cord Injuries: The Dual Challenge of Retained Foreign Bodies and Lead Toxicity Diagnosis

Muhammad Hassaan Amjad[1], Badar Uddin Ujjan[2], Fakhar Hayat[3], Faizuddin[4], Niaz Ahmad Khan[5], Mian Iftikhar Ul Haq[6]*

[1]Medical Officer- Neurosurgery Department- Hameed Latif Hospital – Lahore- Pakistan.
[2]Assistant Professor- Neurosurgery- Dow International Medical College And Hospital Ojha Campus- Karachi- Pakistan.
[3]Consultant Neurosurgeon- Neurosurgery Department- King Hamad University Hospital – Manama- Bahrain.
[4]Assistant Professor- Department Of Neurosurgery- Sheikh Khalifah Bin Zayyad Hospital- Quetta- Pakistan.
[5]Consultant Neurosurgeon- Neurosurgery Department- PIMS- Islamabad- Pakistan.
[6]Assistant Professor- Neurosurgery Unit- Hayatabad Medical Complex Hospital- Peshawar- Pakistan.
Corresponding Author: Mian Iftikhar Ul Haq, Assistant Professor; Email: drmiulhaq@gmail.com

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ABSTRACT

Background: Spinal cord injuries (SCIs) present formidable challenges in the realm of medical diagnosis and treatment. These injuries can result in profound and permanent disabilities, necessitating a multifaceted approach to care. Among the complexities associated with SCIs, the presence of retained foreign bodies (RFBs) and the potential for lead toxicity add layers of diagnostic and therapeutic difficulty. RFBs, often remnants of traumatic events such as gunshot wounds or surgical procedures, can complicate the clinical picture, leading to chronic pain, infections, and neurological deficits. Concurrently, lead toxicity, although rare, can arise from retained metallic objects, posing systemic health risks that require vigilant monitoring and intervention.

Objective: The main objective of this study was to investigate the complexities of spinal cord injuries compounded by retained foreign bodies and the diagnostic challenges posed by lead toxicity.

Methods: This retrospective observational study was conducted at Lahore General Hospital from 2021 to 2023. Data were collected from 78 patients with spinal cord injuries suspected of lead toxicity. Patient data, including demographics, medical history, presenting symptoms, imaging findings, laboratory results, and treatment outcomes, were systematically collected from electronic medical records. Diagnostic modalities such as magnetic resonance imaging (MRI), computed tomography (CT), and X-ray imaging were utilized to identify the presence and location of RFBs. Blood lead levels and other relevant biochemical markers were assessed to evaluate lead toxicity. Treatment strategies varied depending on the nature and severity of the injuries, encompassing surgical removal of RFBs, chelation therapy for lead toxicity, and rehabilitation interventions to address functional deficits. Follow-up assessments were conducted to evaluate the efficacy of treatment and monitor for any complications or recurrence of symptoms. Data were analyzed using SPSS version 25, with subgroup analyses performed to explore associations between variables.

Results: The study included 78 patients with spinal cord injuries, with a mean age of 42.01 ± 9.6 years. Among these patients, 47 (60%) were male and 31 (40%) were female. Gunshot wounds were the most common cause, affecting 35 patients (45%), followed by motor vehicle accidents in 23 patients (30%), and falls in 20 patients (25%). Retained foreign bodies were present in 43 patients (55%), with 9 of these (12%) exhibiting lead toxicity. Significant associations were found between the size of retained foreign bodies and the severity of neurological deficits ($p < 0.001$). Patients who underwent RFB removal showed significantly greater improvement in neurological function compared to those who did not ($p = 0.003$). Pain relief was significantly better in patients without lead toxicity compared to those with lead toxicity ($p = 0.012$). Lead toxicity was associated with delayed recovery ($p = 0.027$), and higher blood lead levels were linked to poorer neurological improvement ($p = 0.019$). Age was significantly associated with the likelihood of RFB presence ($p = 0.045$), and follow-up duration differed significantly between patients with and without lead toxicity ($p = 0.036$).

Conclusion: Spinal cord injuries (SCIs) complicated by retained foreign bodies (RFBs) and lead toxicity present significant diagnostic and therapeutic challenges. The integration of advanced imaging modalities and vigilant monitoring for toxicological complications is essential for effective management. Surgical removal of RFBs and chelation therapy for lead toxicity have shown promising outcomes in improving neurological function and alleviating symptoms.

Keywords: Spinal cord injuries, retained foreign bodies, lead toxicity, gunshot wounds, advanced imaging.

Journal of Health and Rehabilitation Research 2791-156X JHRR

INTRODUCTION

Spinal cord injuries (SCIs) represent a significant challenge in medical diagnosis and treatment due to their potential to cause profound and permanent disabilities. These injuries often necessitate a multifaceted approach to care. Among the complexities associated with SCIs, the presence of retained foreign bodies (RFBs) and the risk of lead toxicity add layers of diagnostic and therapeutic difficulty (1). RFBs, typically remnants from traumatic events such as gunshot wounds or surgical procedures, can complicate the clinical picture, leading to chronic pain, infections, and neurological deficits. Concurrently, lead toxicity, though rare, can arise from retained metallic objects, posing systemic health risks that require vigilant monitoring and intervention (2, 3).

Lead ranks as one of the most severe metallic toxins, and its effects are particularly concerning in vulnerable populations, including children. Lead exposure can come from various sources, such as paint, auto emissions, and other environmental pollutants, making it a widespread public health issue (4, 5). In the context of SCIs, the potential for lead toxicity from retained metallic fragments adds a significant challenge to patient management. Spinal cord injuries are often the result of acute trauma, with motor vehicle accidents, falls, and gunshot wounds being common causes. These injuries not only result in immediate physical harm but also have long-term implications for patients' health, finances, and quality of life (6, 7).

The dual challenge of SCIs complicated by RFBs and lead toxicity necessitates an integrated diagnostic strategy that combines advanced imaging techniques with comprehensive biochemical assessments. This approach is essential to accurately identify and manage these complications, given the intricate interplay between mechanical and toxicological factors (8). Effective management requires the collaboration of multiple specialties, including neurology, toxicology, radiology, and surgery (9, 10).This research aims to explore the intricacies of diagnosing and managing spinal cord injuries complicated by RFBs and lead toxicity, highlighting the latest advancements in diagnostic methodologies and therapeutic interventions. By examining clinical cases and emerging research, this study seeks to elucidate best practices and improve outcomes for patients navigating these complex clinical scenarios (11, 12).

MATERIAL AND METHOD

This retrospective observational study was conducted at Lahore General Hospital from 2021 to 2023. The study included 78 patients who presented with spinal cord injuries and were suspected of lead toxicity. Patient data, including demographics, medical history, presenting symptoms, imaging findings, laboratory results, and treatment outcomes, were systematically collected from electronic medical records.

The inclusion criteria comprised patients with confirmed spinal cord injuries who were suspected of having lead toxicity, either through clinical signs or initial laboratory results. Diagnostic modalities such as magnetic resonance imaging (MRI), computed tomography (CT), and X-ray imaging were utilized to identify the presence and location of retained foreign bodies (RFBs). Blood lead levels and other relevant biochemical markers were assessed to evaluate lead toxicity. The imaging techniques, particularly high-resolution MRI and CT scans, were critical for accurately localizing and characterizing RFBs (13).

Patients' demographic data, such as age, gender, and the cause of spinal injury, were recorded. Gunshot wounds, motor vehicle accidents, and falls were the primary etiologies, with gunshot wounds being the most common cause. Detailed patient histories were taken to understand the context of their injuries and any previous treatments they had undergone. The presence of RFBs was confirmed in 55% of the patients, and among these, 12% exhibited lead toxicity (14).

Treatment strategies varied depending on the nature and severity of the injuries. Surgical removal of RFBs was performed where feasible, and chelation therapy was administered for patients with confirmed lead toxicity. Rehabilitation interventions were also employed to address functional deficits. Follow-up assessments were conducted to evaluate the efficacy of treatment and monitor for any complications or recurrence of symptoms. Patients were regularly monitored for lead levels and neurological function (3).

Ethical approval for the study was obtained from the institutional review board of Lahore General Hospital. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Data were analyzed using SPSS version 25. Subgroup analyses were performed to explore associations between variables. Statistical tests, such as chi-square tests for categorical variables and t-tests for continuous variables, were used to determine the significance of differences between groups. A p-value of less than 0.05 was considered statistically significant. The results were presented as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables (4). The analysis aimed to identify factors associated with the presence of RFBs, the incidence of lead toxicity, and the outcomes of various treatment strategies.

In conclusion, this study systematically collected and analyzed data on spinal cord injury patients with a focus on the dual challenges of retained foreign bodies and lead toxicity. The findings underscore the importance of advanced imaging and vigilant monitoring in managing these complex cases.

RESULTS

The study included 78 patients with spinal cord injuries, with a mean age of 42.01 ± 9.6 years. Among these patients, 47 (60%) were male and 31 (40%) were female. Gunshot wounds were the most common cause of spinal cord injuries, affecting 35 patients (45%), followed by motor vehicle accidents in 23 patients (30%) and falls in 20 patients (25%).

Table 1 Demographic Data of Patients

Parameter	Value
Total Patients	78
Mean Age (years)	42.01 ± 9.6
Gender Distribution	
- Male	47 (60%)
- Female	31 (40%)

Table 2 Demographic Data of Patients

Etiology of SCI	Number of Patients	Percentage
Gunshot wound	35	45%
Motor vehicle accident	23	30%
Fall	20	25%

Out of the 78 patients, 43 (55%) had retained foreign bodies (RFBs). Among these patients, 9 (12%) exhibited lead toxicity. All cases of lead toxicity were among the patients with RFBs, indicating that lead toxicity occurred in 45% of patients with RFBs.

Table 3 Diagnosis of RFBs and Lead Toxicity

Diagnosis	Number of Patients	Percentage of Patients with RFBs	Percentage of Patients with Lead Toxicity
RFBs Present	43	55%	12%
Lead Toxicity Present	9	45%	100%

Significant associations were found between the size of retained foreign bodies and the severity of neurological deficits ($p < 0.001$). Patients who underwent RFB removal showed significantly greater improvement in neurological function compared to those who did not ($p = 0.003$). Pain relief was significantly better in patients without lead toxicity compared to those with lead toxicity ($p = 0.012$). Lead toxicity was also associated with delayed recovery ($p = 0.027$), and higher blood lead levels were linked to poorer neurological improvement ($p = 0.019$). Age was significantly associated with the likelihood of RFB presence ($p = 0.045$), and follow-up duration differed significantly between patients with and without lead toxicity ($p = 0.036$).

Table 4 Outcomes in RFBs and Lead Toxicity

Variable	P-value
Association between RFB size and severity of neurological deficits	<0.001
Comparison of neurological function improvement between RFB removal groups	0.003
Comparison of pain relief between lead toxicity and non-lead toxicity groups	0.012
Association between lead toxicity and delayed recovery	0.027
Comparison of mean blood lead levels between patients with and without neurological improvement	0.019
Association between age and likelihood of RFB presence	0.045
Comparison of follow-up duration between patients with and without lead toxicity	0.036
Association between gender and incidence of lead toxicity	0.081

In summary, this study highlights the complexity of managing spinal cord injuries complicated by retained foreign bodies and lead toxicity. The results emphasize the importance of advanced imaging and vigilant monitoring for toxicological complications to effectively manage these patients. Surgical removal of RFBs and chelation therapy for lead toxicity were associated with improved outcomes in neurological function and pain relief. The study's findings underscore the need for a multidisciplinary approach to address the multifaceted challenges presented by these conditions.

Journal of Health and Rehabilitation Research 2791-156X JHRR

DISCUSSION

The findings of this study shed light on the complexities associated with spinal cord injuries (SCIs) complicated by retained foreign bodies (RFBs) and lead toxicity. The multifaceted nature of these injuries underscored the importance of a comprehensive diagnostic and therapeutic approach to optimize patient outcomes. Gunshot wounds comprised a significant proportion of the SCIs in this cohort, highlighting the severe impact of firearm injuries on public health (15).The presence of RFBs from such traumatic events often led to chronic complications, including pain, infections, and neurological deficits, which complicated the clinical picture and made management more challenging (16).

The integration of advanced imaging modalities, particularly high-resolution MRI and CT scans, proved essential in accurately localizing and characterizing RFBs. This approach enabled more precise surgical planning and better patient outcomes (17) The study's results indicated that patients who underwent surgical removal of RFBs experienced significant improvements in neurological function and pain relief, demonstrating the therapeutic value of such interventions ($p = 0.003$ and $p = 0.012$, respectively). These findings aligned with previous research suggesting that timely and accurate removal of RFBs can mitigate the long-term impact of SCIs (18)

Lead toxicity, although rare, emerged as a significant concern in patients with RFBs. This study found that 12% of patients with RFBs developed lead toxicity, necessitating vigilant monitoring and early intervention. The association between higher blood lead levels and poorer neurological improvement ($p = 0.019$) highlighted the systemic health risks posed by lead-containing materials in RFBs. Early recognition and chelation therapy were crucial in managing these cases and improving patient outcomes This aligns with existing literature emphasizing the need for continuous monitoring of toxicological complications in patients with metallic foreign bodies (19).

The study also identified several factors influencing the likelihood of RFB presence and lead toxicity. Age was significantly associated with the likelihood of RFB presence ($p = 0.045$), and follow-up duration differed significantly between patients with and without lead toxicity ($p = 0.036$). These findings suggest that older patients may be more prone to complications from RFBs, and that long-term follow-up is essential to monitor and address potential toxicological issues. The results also indicated that lead toxicity was associated with delayed recovery ($p = 0.027$), further complicating the clinical management of these patients.

Despite its significant contributions, the study had several limitations. The retrospective nature of the research introduced potential selection bias, and the relatively small sample size may limit the generalizability of the findings. Additionally, the reliance on electronic medical records could have introduced inaccuracies or incomplete data. Future prospective studies with larger sample sizes are needed to validate these findings and further explore the factors affecting diagnostic and therapeutic strategies for SCIs complicated by RFBs and lead toxicity (20, 21).

CONCLUSION

In conclusion, this study underscored the critical need for a multidisciplinary approach in managing SCIs complicated by RFBs and lead toxicity. The integration of advanced imaging techniques and vigilant toxicological monitoring proved essential for effective diagnosis and treatment. Surgical removal of RFBs and chelation therapy for lead toxicity were associated with improved patient outcomes, highlighting the importance of timely and precise interventions. Further research is necessary to develop optimized treatment protocols and enhance the care of patients with these complex clinical scenarios.

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