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Anjlee Shankar
Chandka Medical College Hospital, Larkana

Faheem Soomro
Chandka Medical College Hospital, Larkana

Dipanty Khastoori
Chandka Medical College Hospital, Larkana

Tahira Maqsood
Chandka Medical College Hospital, Larkana

Sajjad Jalbani
Chandka Medical College Hospital, Larkana

See next page for additional authors

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Anjlee Shankar, Faheem Soomro, Dipanty Khastoori, Tahira Maqsood, Sajjad Jalbani, and Alam Ibrahim Siddiqui

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CORRELATION OF MAGNETIC RESONANCE IMAGING FINDINGS WITH CLINICAL OUTCOMES IN ACUTE TRANSVERSE MYELITIS : A COMPREHENSIVE RETROSPECTIVE STUDY

Anjlee Shankar[1], Faheem Soomro[1], Dipanty Khastoori[1], Tahira Maqsood[1], Sajjad Jalbani[1], Alam Ibrahim Siddiqui[1]
[1]Chandka Medical College Hospital, Larkana

Corresponding author: Anjali Shankar *Chandka Medical College Hospital, Larkana* ***Email:*** *anjalikatyara@hotmail.com*

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ABSTRACT

Background and Objective:

Acute transverse myelitis (ATM) is an inflammatory spinal cord disorder presenting with motor, sensory, and autonomic dysfunction. The objective of this study was to assess the prognostic value of spinal MRI findings and treatment timing in predicting neurological outcomes in patients with acute transverse myelitis.

Methods:

A retrospective analysis was conducted on 90 patients diagnosed with ATM at Chandka Medical College Hospital, Larkana, between January 2021 and December 2023. All patients underwent spinal MRI at presentation, and imaging characteristics—including lesion location, longitudinal extent, and enhancement pattern—were recorded. Clinical outcomes were assessed at one month, three months, and one year using the Modified Rankin Scale (mRS) and the ASIA Impairment Scale (AIS). Statistical tests evaluated associations between MRI findings, treatment timing, and recovery patterns.

Results:

The mean age was 41.5 ± 5 years; 54 patients (60%) were male. MRI revealed normal findings in 20 patients (22.2%) and abnormalities in 70 (77.8%). Overall, 20 patients (22.2%) achieved full recovery, 52 (57.7%) showed partial improvement, and 18 (20%) had no recovery. Normal MRI strongly predicted favorable outcomes (85% full recovery; $p < 0.0001$). Early treatment (≤3 days) significantly improved recovery rates (33.3% vs. 11.5%; $p = 0.0088$).

Conclusion:

MRI characteristics and early therapeutic intervention are key predictors of neurological recovery in ATM. Normal MRI findings and prompt treatment initiation were associated with significantly better outcomes, emphasizing the importance of early imaging and rapid management to reduce long-term disability.

Keywords:

Acute Transverse Myelitis, Diagnostic Imaging, Magnetic Resonance Imaging, Neuromyelitis Optica, Multiple Sclerosis, Prognosis, Spinal Cord Diseases

INTRODUCTION

Transverse myelitis (TM) is a rare yet clinically significant inflammatory disorder of the spinal cord, characterized by acute or subacute involvement of motor, sensory, and autonomic pathways. The condition may present with subtle sensory disturbances or progress rapidly to profound neurological deficits, including complete paralysis and bowel or bladder dysfunction.[1] TM may occur idiopathically or arise secondary to infections, autoimmune diseases, or systemic inflammatory conditions; however, identifying the precise etiology remains a persistent challenge due to the heterogeneity of its underlying mechanisms.[2] Although inflammation may affect any segment of the spinal cord, lesions most commonly occur within the thoracic region, contributing to a variable clinical picture that often complicates timely diagnosis. Epidemiological patterns indicate a bimodal distribution, with peak incidence observed among adolescents aged 10–19 years and adults

in their thirties.[3] Patients frequently present with acute lower back pain followed by progressive limb weakness, sensory loss, and a spectrum of autonomic disturbances such as urinary urgency, retention, or fecal incontinence, all of which can significantly impair functional independence. Given the potential for rapid neurological decline, early recognition and intervention are essential to reduce the risk of long-term disability.[4]

Magnetic resonance imaging (MRI) remains the diagnostic modality of choice, enabling visualization of intramedullary lesions and differentiation from other neuroinflammatory or demyelinating conditions. Brain MRI is often performed concurrently to evaluate for disorders such as multiple sclerosis.[5] In cases where MRI is unavailable or contraindicated, CT myelography may be used, albeit with lower diagnostic sensitivity. Clinical evaluation is commonly supplemented by validated functional assessment tools, including the American Spinal Injury Association (ASIA) Impairment Scale and the Modified Rankin Scale, which allow clinicians to quantify neurological impairment and monitor recovery trajectories over time.[6,7] Despite advancements in imaging technologies and standardized clinical assessments, a notable gap persists in understanding how MRI characteristics correlate with clinical outcomes in TM. Limited evidence linking radiological patterns to functional recovery hinders clinicians' ability to predict prognosis and tailor therapeutic approaches effectively. High-dose intravenous corticosteroids remain the cornerstone of acute management, yet treatment responses vary considerably, and a proportion of patients require escalation to plasmapheresis or other immunomodulatory therapies.[8] Recovery is similarly unpredictable, ranging from near-complete restoration of function to persistent deficits such as spasticity, neuropathic pain, and autonomic dysfunction, all of which may adversely affect long-term quality of life.[9]

Addressing this knowledge gap is essential for improving prognostication and clinical decision-making. Therefore, the present study aims to evaluate the association between MRI findings and functional outcomes in patients presenting with acute transverse myelitis, with the objective of identifying imaging features that may better inform early prognostic assessment and guide individualized treatment planning.

METHODS

This cross-sectional observational study was carried out at Chandka Medical College Hospital (CMCH), Larkana, over a three-year period from January 2021 to December 2023. A total of 90 patients presenting with acute or subacute bilateral motor weakness accompanied by a clinically defined sensory level were recruited through consecutive sampling from the Department of Neurology, where they were referred for evaluation of suspected myelopathy.

All enrolled participants underwent magnetic resonance imaging (MRI) of the spinal cord at the clinically relevant level to support diagnostic confirmation and guide initial management. Eligibility was based on the diagnostic criteria for acute transverse myelitis (ATM), which required the presence of acute or subacute paraparesis evolving within 12 hours to three weeks, radicular or belt-like pain, bladder or bowel dysfunction, and a clearly demarcated sensory level characterized by impaired pain and temperature sensation with relative preservation of vibration and proprioception. MRI confirmation was mandatory and included: (i) involvement of more than 50% of the cord's cross-section on axial images, (ii) T2-weighted hyperintense lesions with cord swelling on sagittal views, (iii) isointense or hypointense signals on T1-weighted images, and (iv) patchy gadolinium enhancement on post-contrast imaging. Patients aged 13–70 years of either sex were eligible if clinical follow-up at one month, three months, and one year was documented, along with complete treatment records confirming administration of corticosteroids, intravenous immunoglobulin (IVIg), or plasmapheresis.[10,11] Strict exclusion criteria were applied. Patients with a history of spinal trauma; clinical features suggestive of progressive spastic paraparesis or hemicord syndrome; alternative diagnoses such as multiple sclerosis (MS), neuromyelitis optica (NMO), spinal cord infarction, or malignancy; incomplete clinical or radiological data; or evidence of acute infectious myelitis were excluded. Individuals with pre-existing spinal cord disease or prior neurological injury were also not considered eligible.[12]

Upon admission, all patients underwent 1.5-Tesla MRI of the cervical and thoracic spine, including sagittal and axial T1-, T2-, and post-contrast sequences. A baseline brain MRI was performed at presentation to exclude pre-existing demyelinating lesions suggestive of established MS. Patients whose baseline brain MRI fulfilled the revised McDonald criteria for MS were excluded from the study. However, those with normal or non-specific brain MRI findings remained enrolled and were monitored during follow-up for new clinical attacks, radiological progression, or serological markers, such as the anti-AQP4 antibody, that could subsequently establish a diagnosis of MS or NMOSD. This approach ensured that only patients without an established demyelinating disorder at presentation were included, while allowing the study to capture individuals who

later converted to MS or NMO during follow-up. Clinical and demographic information including age, sex, residence, symptom duration, neurological signs, and functional status was documented on a standardized proforma. Follow-up evaluations also assessed recurrence, conversion to MS or NMO, and long-term complications such as persistent paralysis or sphincter dysfunction. Functional outcomes were measured using the mRS at diagnosis and at the most recent follow-up. Although additional neurological disability scoring systems would have been desirable, inconsistent availability in medical records precluded their use.[14,15]

All patients received standardized therapeutic interventions. First-line treatment included intravenous corticosteroids (methylprednisolone or dexamethasone), initiated during hospital admission or the earliest outpatient encounter. Cases with suboptimal response were managed with IVIg or plasmapheresis, according to clinical judgment. Treatment response was classified as improvement, no change, or deterioration, based on clinician documentation and patient-reported progress. Rehabilitation support was provided to enhance recovery, consisting of passive and active range-of-motion exercises, gait training with assistive devices, antispasmodic therapy for spasticity, clean intermittent catheterization for neurogenic bladder, and structured bowel programs.[16]

Ethical approval was obtained from the Institutional Ethical Review Committee of Chandka Medical College Hospital. Written informed consent was secured from all patients or their legal guardians. Data analysis was performed using IBM SPSS version 21.0. Continuous variables, such as age and duration of symptoms, were summarized as mean ± standard deviation (SD), while categorical variables, including gender, residence, MRI characteristics, and clinical outcomes were expressed as frequencies and percentages. Associations between MRI features, lesion location, treatment modality, and clinical outcomes were examined using the chi-square test or Fisher's exact test when required. The independent-samples t-test and one-way ANOVA were used to evaluate the effect of time-to-treatment on outcome measures. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 90 patients diagnosed with ATM were enrolled in the study. The cohort included 54 males (60%) and 36 females (40%), with a mean age of 41.5 ± 5 years (range: 13–70 years). Most patients (74.4%) were above 30 years of age. The time from symptom onset to peak neurological deficit ranged from 12 hours to 3 weeks. Tetraplegia was documented in 31 patients (34.4%) and paraplegia in 39 patients (43.3%). All individuals presented with motor weakness, sensory impairment, and sphincter dysfunction, predominantly urinary incontinence. Spinal MRI was performed in all cases within 1–25 days of symptom onset. Cervical cord involvement was identified in 31 patients (34.4%), whereas dorsal cord lesions were seen in 39 (43.3%). Patchy multisegmental involvement was present in 12.8% and contiguous lesions extending over more than three segments in 7.1%. Brain MRIs were performed in 44 patients at presentation, and all were reported as having no specific abnormalities diagnostic of MS at that time.

Patients whose baseline brain MRI fulfilled the revised McDonald criteria for MS were excluded from enrollment. However, during longitudinal follow-up, based on subsequent clinical attacks and serological confirmation (e.g., anti-AQP4 antibodies), nine patients (12.8%) were subsequently diagnosed with MS and five patients (7.1%) with neuromyelitis optica (NMO). CSF analysis demonstrated normal to mildly elevated protein levels (56–105 mg/dL). Oligoclonal bands were negative in all patients, and IgG indices were within normal limits. Clinical outcomes were assessed at one month, three months, and one year. Full recovery was documented in 22.2% of patients, partial recovery in 57.7%, and no recovery in 20%. Urinary incontinence persisted in 80% of cases, while urinary retention was observed in 20%, and bowel dysfunction in 2.2%.

Functional outcomes showed significant improvement over time. At admission, 23.3% haad mRS score of 4 and 17.7% had a score of 5. By final follow-up, 30% achieved an mRS score of 0, and only 7.7% remained at score 5. Similarly, on the ASIA Impairment Scale (AIS), 37.7% were classified as AIS-A on admission, with none remaining in this category at final evaluation. The proportion of patients who achieved AIS-E (normal function) increased from 0% at baseline to 30% at follow-up.

A strong relationship was observed between MRI findings and clinical outcomes. Among patients with normal MRI results, 85% achieved complete recovery, whereas only 4.3% of those with abnormal MRI findings experienced full recovery ($p < 0.0001$). No significant associations were found between lesion location and outcome ($p = 0.9391$) or between treatment type and outcome ($p = 0.4277$), although outcomes trended better in patients receiving combination therapy. Table 1 demonstrates relation of MRI findings with clinical outcomes.

Table 1: MRI Findings vs. Clinical Outcome Sympathetic Domains)				
MRI Status	**Full Recovery n (%)**	**Partial Recovery n (%)**	**No Recovery n (%)**	**Total**
Normal (n=20)	17 (85%)	3 (15%)	0 (0%)	20
Abnormal (n=70)	3 (4.3%)	49 (70%)	18 (25.7%)	70
P value: < 0.0001				
Lesion Location vs. Outcome				
Lesion Location	**Full Recovery n (%)**	**Partial Recovery n (%)**	**No Recovery n (%)**	**Total**
Cervical (n=31)	5 (16.1%)	20 (64.5%)	6 (19.4%)	31
Dorsal (n=39)	6 (15.4%)	25 (64.1%)	8 (20.5%)	39
Both (n=13)	2 (15.4%)	7 (53.8%)	4 (30.8%)	13
P value: 0.9391				

(Early treatment (≤3 days from symptom onset) was significantly associated with improved outcomes. In this subgroup, 33.3% achieved full recovery, in contrast to only 11.5% of those treated after more than 7 days ($p = 0.0088$).

To determine whether MRI status independently predicted outcome beyond the effect of early treatment, a stratified analysis was conducted. Within each treatment-timing subgroup (≤3 days, 4–7 days, >7 days), patients with normal MRI findings had markedly higher rates of full recovery than those with abnormal MRI findings ($p < 0.05$ for all subgroups).

DISCUSSION

This study provided important insight into the clinical and radiological determinants of recovery in ATM, with particular emphasis on the prognostic value of spinal MRI and the timing of therapeutic intervention. The demographic and clinical profile of the cohort, including the predominance of middle-aged adults, male majority, and the high frequency of paraparesis or tetraparesis accompanied by sensory and sphincter dysfunction, mirrored patterns consistently reported in regional and international literature.[17,18] These findings reaffirmed the substantial functional burden associated with ATM at presentation and highlighted the need for timely diagnostic and therapeutic strategies. The most notable observation was the strong association between MRI findings and clinical outcomes. Patients with normal spinal MRI achieved markedly better recovery rates compared with those exhibiting radiologically evident lesions, consistent with previous studies indicating that normal MRI reflects a milder or reversible inflammatory insult.[19,20] Abnormal MRI features such as T2 hyperintensities, cord swelling, and patchy gadolinium enhancement correlated with poorer outcomes, reinforcing earlier reports that spinal cord edema and extensive signal abnormalities represent more severe pathological involvement that may limit neurological recovery.[5,21] These data collectively supported the dual diagnostic and prognostic role of MRI in the evaluation of ATM.

Early initiation of immunomodulatory therapy emerged as an additional predictor of favorable outcome. Patients who received treatment within three days of symptom onset demonstrated substantially higher rates of full recovery than those treated after one week, underscoring the importance of minimizing treatment delays in limiting irreversible tissue injury.[9,22] This finding held particular relevance in resource-limited settings, where delays in referral and neuroimaging access remain common and may adversely affect long-term functional outcomes.

A concern regarding potential confounding was present, given that both normal MRI and early treatment appeared to favor better recovery. The stratified subgroup analysis addressed this issue directly and demonstrated that MRI status remained a powerful independent predictor of outcome. Even in the subgroup treated more than seven days after symptom onset, all three patients with normal baseline MRI achieved complete recovery, while none of the twenty-three patients with abnormal MRI findings did so. This pattern reinforced the prognostic primacy of the initial radiological appearance of the spinal cord. It suggested that

although prompt treatment was essential for improving outcomes, the intrinsic severity of spinal cord involvement, as reflected on MRI, played a fundamental role in determining recovery potential, independent of treatment timing. Lesion location did not significantly influence outcome, a finding that paralleled several earlier reports suggesting that lesion burden and extent, rather than anatomical level, are more meaningful determinants of neurological recovery.[12,23] Similarly, although combination therapy with corticosteroids and either intravenous immunoglobulin (IVIg) or plasmapheresis showed a trend toward improved outcomes, statistical significance was not achieved. The small sample sizes in each treatment subgroup and the non-randomized nature of treatment allocation may have limited the ability to detect a true difference. Functional assessment using both the ASIA Impairment Scale and the Modified Rankin Scale demonstrated progressive improvement across the follow-up period. The transition of many patients from severe baseline deficits to significantly higher functional categories at one year highlighted the combined impact of pharmacological therapy and structured rehabilitation.[15,24.] The observation that 30% of patients achieved full neurological recovery by the end of follow-up further supported the value of comprehensive, multidisciplinary care.

The study possessed several strengths, including a clearly defined cohort, standardized diagnostic criteria, consistent follow-up, and rigorous analysis of radiological and clinical predictors. The incorporation of subgroup analysis to address potential confounding strengthened the validity of the conclusions regarding the independent prognostic role of MRI. However, several limitations warranted acknowledgment. The retrospective, single-center design limited generalizability, and sample size constraints reduced statistical power for treatment comparisons. MRI was not repeated during follow-up, preventing correlation between radiological evolution and clinical improvement. Additionally, although ASIA and mRS scores were consistently documented, more granular functional outcome tools and quality-of-life measures were not available. These limitations suggested the need for future prospective, multicenter studies employing serial MRI, standardized disability indices, and stratified therapeutic protocols to better delineate recovery trajectories in ATM.[19,25] Overall, the study demonstrated that MRI characteristics and early treatment were significant predictors of neurological outcome in acute transverse myelitis. The findings underscored the importance of early imaging and prompt initiation of immunomodulatory therapy while demonstrating that the inherent severity of spinal cord involvement, as depicted by MRI, remained a primary determinant of recovery. A coordinated rehabilitative approach and continued long-term monitoring were essential components in optimizing patient outcomes and minimizing long-term disability in this complex and heterogeneous condition.

CONCLUSION

This study demonstrated that magnetic resonance imaging plays a critical prognostic role in acute transverse myelitis, with normal MRI strongly predicting favorable neurological recovery independent of treatment timing. Early initiation of immunomodulatory therapy further enhanced outcomes, underscoring the importance of prompt diagnosis and management. Although lesion location and treatment type showed no significant impact, functional improvement was substantial with coordinated rehabilitation. These findings highlight MRI-based risk stratification and early therapeutic intervention as essential components in optimizing recovery and guiding clinical decision-making in ATM.

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Anjali Shankar: Concept, Design, Data collection, manuscript writing
Faheem Soomro: Data collection, manuscript writing
Dipanty Khastoori; Data Analysis, Manuscript writing
Tahira Maqsood; data collection, data analysis, manuscript writing
Sajjad Jalbani; data analysis, manuscript writing
Alam Ibrahim Siddiqui; data interpretation, manuscript revision

All the authors have approved the final version to be published and agree to be accountable for all aspects of the work.