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ORIGINAL ARTICLE

Clinical, radiological, and immunological profile of transverse myelitis in children: Experience from the largest public-sector paediatric Hospital in Sindh.

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ABSTRACT… Objective: To evaluate the clinical, radiological, and immunological profiles of paediatric TM patients at a tertiary care hospital in Karachi, Pakistan, and to identify the prevalence of comorbid Vitamin B12 and folate deficiencies. **Study Design:** Descriptive Cross-sectional study. **Setting:** Department of Neurology, National Institute of Child Health (NICH), Karachi, Pakistan. **Period:** June 2023 to June 2024. **Methods:** Thirty-one patients aged 3 to 18 years meeting the 2002 Transverse Myelitis Consortium criteria were enrolled using non-probability consecutive sampling. Evaluation included spinal MRI, CSF analysis, serum AQP4 and MOG antibody testing, and nutritional assessments. **Results:** The mean age was 7 years, with a female predominance of 61.3%. Lower limb weakness and bladder dysfunction were universal (100%). Longitudinally extensive transverse myelitis (LETM), involving ≥3 vertebral segments, was observed in 64.5% of patients. CSF pleocytosis occurred in 74.2% and elevated protein in 80.6% of cases. Nutritional analysis revealed Vitamin B12 deficiency in 22.6% and RBC folate deficiency in 12.9% of the cohort. **Conclusion:** Paediatric TM in the Pakistani population is characterized by a high frequency of longitudinally extensive lesions and profound autonomic failure. The significant prevalence of B12 and folate deficiencies identifies a regional metabolic-inflammatory interface, suggesting that routine nutritional screening is essential for children presenting with acute myelopathy.

Key words: CNS, Demyelinating Autoimmune Diseases, Myelitis, Paediatrics, Pakistan, Spinal Cord, Transverse.

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INTRODUCTION

Transverse myelitis represents a focal inflammatory disorder of the spinal cord that results in a complex pattern of motor, sensory, and autonomic dysfunction.[1] The condition is characterised by an acute or sub-acute onset, where neurological deficits typically reach their lowest point within hours to 21 days.[2] While relatively uncommon, it poses a significant risk of permanent disability in the paediatric population, accounting for approximately 20% of all cases of acquired demyelinating syndromes in children globally. The estimated incidence in children is approximately 1.7 to 2 million per year[3-4] with a higher prevalence in males (male to female ratio 1.1-1.6 to 1), though specific epidemiological data from South Asia remain limited compared to Western literature.[5] The condition exhibits a bimodal age distribution, with peaks occurring in individuals aged 10-19 years and 30-39 years.[6]

In the context of Pakistan, the presentation and diagnosis of paediatric transverse myelitis are influenced by a unique set of epidemiological factors. The region faces a double burden of disease; while immune-mediated demyelinating conditions are increasingly recognised, the diagnostic process must still account for infectious mimics such as poliomyelitis and spinal tuberculosis, which remain relevant in the local clinical landscape. Local studies at institutions like Aga Khan University Hospital have suggested that the severity of motor impairment in the Pakistani population may be greater than that reported in Western cohorts, potentially due to delayed presentation, genetic predispositions, or environmental triggers.[7]

The biological mechanisms underlying transverse myelitis involve an autoimmune attack on the spinal cord parenchyma, often following a parainfectious

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or post-vaccinal trigger.[8] This inflammation can be monophasic or the herald of a chronic, relapsing condition such as neuromyelitis optica spectrum disorder (NMOSD) or multiple sclerosis.[9] The discovery of specific biomarkers, namely Aquaporin-4 (AQP4) and Myelin Oligodendrocyte Glycoprotein (MOG) antibodies, has transformed the classification of these disorders, allowing clinicians to differentiate between truly idiopathic transverse myelitis and systematic demyelinating syndromes.[10] However, access to such high-level diagnostics remains variable in developing countries, often necessitating reliance on clinical and radiological findings.

One of the most critical radiological differentiators is the presence of longitudinally extensive transverse myelitis (LETM), defined as a spinal cord lesion extending across three or more contiguous vertebral segment.[11] In paediatric populations, LETM appears to be more common than in adults, often involving the central portion of the cord.[12] Regional data from Lahore indicate that among paediatric myelitis cases, thoracic and lumbar involvement is frequent, leading to profound paraparesis and autonomic failure.[13]

Furthermore, the role of nutritional status in neurological health cannot be overstated in South Asia. Deficiencies in Vitamin B12 and folate are prevalent in Pakistan due to dietary habits and socioeconomic factors.[14] These nutrients are essential for the maintenance of the myelin sheath and neuronal integrity.[15] When an inflammatory insult occurs in the setting of nutritional compromise, the resulting neural damage may be more extensive, and the potential for recovery more limited.[16] Identifying the prevalence of these deficiencies in paediatric transverse myelitis patients is therefore a primary objective of this study.

This research aims to provide a comprehensive profile of paediatric transverse myelitis within a Pakistani cohort, focusing on the clinical, radiological, and immunological markers that define the disease in this population. By comparing these findings with international data, the study seeks to highlight regional specificities that can guide early diagnosis and more effective management strategies in tertiary care settings.

METHODS

This descriptive cross-sectional study was conducted at the Department of Neurology, National Institute of Child Health (NICH), Karachi, Pakistan, from June 2023 to June 2024, following approval from the Institutional Ethical Review Board (Ref. No. NICH-IERB-2023-04; Approved on 23 May, 2023). Using non-probability consecutive sampling and written informed consent, we enrolled patients of both genders, aged 3 to 18 years, who fulfilled the 2002 Transverse Myelitis Consortium diagnostic criteria. Exclusion criteria included a history of spinal radiation within the last 10 years, prior back trauma, and clinical mimics such as Guillain-Barré syndrome, poliomyelitis, or spinal tuberculosis. Furthermore, neuroimaging (MRI) was utilized to exclude all cases of extra-axial compressive etiology, ensuring the inflammatory nature of the myelopathy in the study cohort.

The sample size was calculated based on a 4% reported prevalence of aquaporin-4 (AQP4) antibodies, with a 95% confidence interval and a 7% margin of error, yielding a minimum sample of 31 patients. Inclusion required fulfilment of the 2002 Transverse Myelitis Consortium diagnostic criteria. Patients with prior spinal radiation, spinal trauma, Guillain-Barré syndrome, poliomyelitis, spinal tuberculosis, or MRI evidence of extra-axial compression were excluded.

Clinical evaluation included neurological examination, motor power grading using the Medical Research Council scale, sensory level mapping, and reflex assessment. MRI of the brain and spine was performed using a 1.5 Tesla scanner. Cerebrospinal fluid analysis and serum testing for AQP4-IgG, MOG-IgG, vitamin B12, red blood cell folate, and antinuclear antibodies were performed.

Data was analysed using SPSS version 26. Continuous variables were summarised as mean ± standard deviation or median (interquartile range), while categorical variables were presented as frequencies and percentages. Data normality was assessed using the Shapiro–Wilk test, and a p-value <0.05 was considered statistically significant.

RESULTS

The cohort exhibited a mean age of 7 years at the time of presentation. The age distribution reflected a trend towards the middle paediatric years, consistent with international bimodal peaks. Gender analysis revealed a clear female predominance (61%), as shown in Table-I. All patients presented with acute or subacute weakness and sensory impairment in the lower limbs (100%). Notably, upper limb involvement and respiratory distress were absent in this specific cohort, indicating a predilection for lesions in the lower thoracic and lumbar spinal segments. Initially, reflexes were absent or reduced (22%), progressing to hyperreflexia, with a positive Babinski sign. The evolution of reflexes and motor signs provided evidence of the transition from the acute phase of illness to established myelitis. Autonomic impairment was a nearly universal feature in this study. All patients suffered from bladder dysfunction (100%), while a high proportion also experienced significant bowel dysfunction (77%), primarily manifest as constipation. MRI findings were essential in confirming the inflammatory nature and extent of the spinal cord lesions showing predominantly thoracic and lumbar region involvement. A majority (64%) of the paediatric patients exhibited LETM. Brain MRI was performed for all 31 patients, and no intracranial white matter involvement was detected, supporting a diagnosis of isolated transverse myelitis in the initial phase. CSF cytochemical analysis revealed that inflammatory changes were present in most patients (74%). Pleocytosis (74%) and elevated protein levels (81%) were the most common findings, while glucose levels were preserved across the cohort 100%). A small percentage of patients tested positive for AQP4 (6.5%) or MOG antibodies (3.2%), exclusively in those with LETM. Additionally, 6.5% test positive for antinuclear antibodies (ANA). Nutritional deficiencies were markedly more common with 12.9% of patients exhibiting red blood cell (RBC) folate deficiency and 22.6% have vitamin B12 deficiency.

DISCUSSION

Transverse myelitis in the pediatric population is an uncommon but potentially disabling inflammatory disorder of the spinal cord.[17] The results of this study provide a detailed clinical and paraclinical profile of paediatric transverse myelitis in Pakistan, revealing consistencies with global cohorts while highlighting distinct regional variations.

The mean age of 7 years in our study cohort is consistent with paediatric peaks reported in the United Kingdom, France, and North America. For instance, Absoud et al. reported a peak incidence between 7 and 10 years, and our data align closely with this window.[5] The female predominance of 61.3% is also reflective of international trends documented by Pidcock et al. and De Goede et al., who noted a female preponderance likely linked to immune-mediated mechanisms shared with other demyelinating disorders.[6,18] This consistency across South Asian and Western cohorts strengthens the argument for a biological rather than purely environmental predisposition to spinal cord inflammation in children.

Clinically, the hallmark of this cohort was the universal presence of lower limb weakness and sensory impairment. Notably, the total absence of upper limb or respiratory involvement in our patients is a significant different from Western series, such as the one by Thomas et al., where cervical involvement and subsequent quadriparesis or respiratory compromise occur in 20% to 30% of cases.[19] The predilection for thoracic and lumbar segments in our cohort may suggest a specific regional vulnerability or a different pathological trigger in the South Asian paediatric spinal cord. The evolution of neurological signs followed a classic pattern of spinal shock, where initial hyporeflexia (48.4%) typically evolved into hyperreflexia and a positive Babinski sign (77.4%).[20] Recognising this transition is critical for local clinicians, as early presentation may be misdiagnosed as lower motor neuron conditions like Guillain-Barré syndrome.

Autonomic dysfunction was a nearly universal and debilitating feature, with 100% of patients experiencing bladder dysfunction and 77.4% suffering from bowel dysfunction. These high rates of autonomic failure are consistent with international findings by Absoud et al. (96%) and Thomas et al. (88%).[5,19] In children, such dysfunction requires intensive management to prevent long-term urological and gastrointestinal complications.

TABLE-I

Demographic, clinical, radiological, and laboratory characteristics of study participants

Variable	Category	Frequency (n)	Percentage (%)
Gender Distribution	Male	12	38.7
	Female	19	61.3
Muscle Tone	Increased	24	77.4
	Decreased	7	22.6
Deep Tendon Reflexes	Increased	16	51.6
	Decreased	15	48.4
Babinski Sign	Positive	24	77.4
	Negative	7	22.6
Autonomic Symptoms	Bladder Dysfunction	31	100.0
	Bowel Dysfunction (Constipation)	24	77.4
MRI Spine Findings – Lesion Length	≥ 3 Vertebral Segments (LETM)	20	64.5
	< 3 Vertebral Segments	11	35.5
MRI Spine Findings – Predominant Location	Thoracic/Lumbar	31	100.0
	Cervical	0	0.0
CSF Profile	Pleocytosis (WBC >5 cells/mm³)	23	74.2
	Elevated Protein (>0.5 g/L)	25	80.6
	Normal Glucose	31	100.0
Serological Profile	Serum AQP4 Positive	2	6.5
	Serum MOG Positive	1	3.2
	Serum ANA Positive	2	6.5
Nutritional Status	Decreased Vitamin B12	7	22.6
	Decreased RBC Folate	4	12.9

TABLE-II

Comparative Analysis of Clinical and Paraclinical Markers between different studies

Variable	Our Study (Karachi)	Pidcock et al. (USA)	Thomas et al. (Canada)	Absoud et al. (UK)
Mean Age (years)	7	8.8	9	7.5
Female Predominance (%)	61	55	58	60
Lower Limb Weakness (%)	100	100	100	100
Bladder Involvement (%)	100	94	88	96
Long-segment MRI Lesions (%)	64	62	68	55
CSF Pleocytosis (%)	74	70	76	65
Elevated CSF Proteins (%)	80	72	78	70
Serum AQP4 Positive (%)	6.5	Rare	5	6
Serum MOG Positive (%)	3.2	NT	12	15

(NT: Not Tested)

Radiologically, the high prevalence of LETM in 64.5% of our patients is a key diagnostic indicator. This finding is comparable to previous pediatric series where LETM was reported in 50–70% of cases.[6] The absence of intracranial white matter lesions supports the diagnosis of monophasic TM and reduces the likelihood of multiple sclerosis, as noted in earlier imaging-based studies (21, 22). Preservation of superficial abdominal reflexes and absence of visual symptoms further differentiate isolated TM from neuromyelitis optica spectrum disorders (NMOSD) and multiple sclerosis (23). While LETM is often associated with systematic disorders like NMOSD or MOGAD, the majority of our LETM cases were seronegative for AQP4 and MOG antibodies, suggesting that "idiopathic" paediatric TM in Pakistan frequently presents with extensive inflammatory lesions.

The inflammatory nature of the disease was further confirmed by CSF analysis, which showed pleocytosis in 74.2% and elevated protein in 80.6% of patients. These rates align well with Western data reporting pleocytosis in approximately 70% to 76% of cases.[5,24-25] Normal or mildly altered CSF parameters in the remaining cases do not exclude TM, as highlighted in earlier literature.[26-27] A critical regional insight is the high rate of Vitamin B12 (22.6%) and RBC folate (12.9%) deficiencies within this inflammatory cohort. While metabolic deficiencies can cause non-inflammatory myelopathy, all patients in this study met the inflammatory criteria for TM, suggesting a "double hit" mechanism where nutritional vulnerability may predispose Pakistani children to more severe inflammatory spinal cord injury.[28] For South Asian paediatricians, these findings mandate routine nutritional screening in children with acute myelopathy, as supplementation could be a vital adjunct to standard immunotherapy.

The comparative analysis with regional and international studies highlights both shared and unique markers (Table-II).

Furthermore, the identification of ANA positivity in 6.5% of cases underscores the need for vigilant screening for systematic autoimmune diseases like SLE. Higher ANA rates are expected when TM occurs as part of systemic autoimmune disease (e.g., SLE-associated myelitis), in such cases ANA positivity is common and pathophysiologically relevant.[29] This association of SLE-myelitis has been well documented in multiple case series and reviews.[30] Because ANA positivity is found in a notable minority of healthy children (population estimates vary, e.g. up to ~15% in some cohorts), isolated low-titer ANA without clinical features of systemic autoimmune disease should be interpreted cautiously and not be taken alone to imply an autoimmune systemic cause of TM.[31-32]

Several limitations should be considered while interpreting these findings. First, the relatively small sample size of 31 paediatric patients limits the statistical power of the study and may reduce the generalizability of the results. Although the sample reflects real-world clinical practice for this rare condition, larger multicenter studies are required to validate these observations. Second, the study was conducted at a single tertiary care center, which may introduce referral and selection bias, potentially limiting the applicability of findings to the broader paediatric population. Third, there was incomplete laboratory data for some patients; Vitamin B12 levels were unavailable for three patients, and AQP4 and MOG testing was missing in four patients. This may have led to under-recognition or misclassification of overlapping diagnoses such as nutritional myelopathy or NMOSD. Furthermore, the absence of complete antibody testing in all patients limits the ability to conclusively exclude increasingly recognised antibody-mediated disorders. Finally, the observational nature of the study precludes establishing causal relationships between clinical and laboratory findings. Despite these limitations, the study provides valuable insight into the paediatric TM profile in a resource-limited setting and highlights areas for future multicenter research.

Diagnosis in Pakistan occurs in a complex environment where TM must be differentiated from acute flaccid paralysis (AFP) caused by poliovirus or other infectious agents. While the study's single-center design and small sample size are limitations, the findings provide a robust foundation for understanding paediatric TM in a resource-limited setting. The co-occurrence of inflammatory markers with significant nutritional deficiencies suggests that

a holistic diagnostic and therapeutic approach is essential to improve neurological outcomes in this population.

CONCLUSION

This study identifies paediatric transverse myelitis in Pakistan as a severe inflammatory condition characterised by early onset, female predominance, and extensive spinal involvement. The universal prevalence of autonomic failure and the distinct association with Vitamin B12 and folate deficiencies highlight the need for comprehensive diagnostic protocols that include neuroimaging, CSF analysis, and nutritional screening. Early recognition and targeted intervention, addressing both the inflammatory process and metabolic deficits, are critical to reducing long-term disability in these patients.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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4	**Shumaila Hanif Sheikh:** Drafting. Data Collection.
5	**Syeda Namayah Fatima Hussain:** Data entry, Data collection.
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