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Functional impairments and disability profile of CNS non-MS inflammatory demyelinating diseases: A hospital-based study

Murtaza Noor[1*], Feroze A Mir[1], Ravouf Asimi[1], Mushtaq Ahmad Bhat[2], Naseer Ahmad Choh[3], Mohammad Maqbool Wani[1], Injeela Masoom[1], Zahid Qazi[1], Usaid Ali Shah[1], Anisa Shafi Najar[1], and Adil Bashir[1]

[1]Department of Neurology, Sher-i-Kashmir Institute of Medical Sciences, Soura, Srinagar, Jammu & Kashmir - 190011
[2]Department of Pediatrics, Sher-i-Kashmir Institute of Medical Sciences, Soura, Srinagar, Jammu & Kashmir - 190011
[3]Department of Radiodiagnosis and Imaging, Sher-i-Kashmir Institute of Medical Sciences, Soura, Srinagar, Jammu & Kashmir - 190011

Abstract

Background: Non-MS CNS inflammatory demyelinating diseases are pathologically primary demyelination caused by immunological injury to oligodendrocytes and as a result are clinically severe and can present either as clinically isolated syndromes or recurrent episodes with residual disability.

Methods: A cross-sectional observational study was conducted on 65 patients with different non-MS CNS inflammatory demyelinating diseases to study their course (monophasic or recurrent) and the functional impairments such as extent of fatigue, depression (PHQ9 score), motor disability (EDSS score) and bladder-bowel dysfunction (using bladder and bowel control scores respectively). Respective standard scales were used for paediatric groups. The data was then analysed by appropriate statistical methods and observations recorded.

Results: Neuromyelitis optica spectrum disorder (NMOSD) and myelin oligodendrocyte glycoprotein antibody-associated disease (MOGAD) cases had a monophasic and a recurrent course in comparable frequencies, while ADEM and idiopathic groups were strictly monophasic. Highest EDSS at onset was noted in NMOSD, ADEM and LETM reflecting their disabling nature. EDSS declined significantly ($p=0.04$) from onset to discharge but idiopathic LETM and NMOSD had residual disability. There was significant fatigue seen in most groups but with no significant association with disease type and recurrence ($p =0.44$). Depression was also co-prevalent but again had no significant association with disease groups and number of episodes ($p =0.66$). Bladder-bowel dysfunction was severe and significant ($p<0.001$) among NMOSD, ADEM and LETM cases.

Conclusion: This study showed a significant functional disability experienced by patients of non-MS CNS inflammatory demyelinating diseases in terms of fatigue, depression, motor weakness and bladder-bowel dysfunction; and underscores the need to recognise them early, as the motor disability scores declined significantly at discharge.

Keywords: central nervous system; primary demyelination; NMOSD; myelin; oligodendrocyte; encephalomyelitis; myelitis; idiopathic optic neuritis

Introduction

Neuromyelitis optica spectrum disorder (NMOSD), myelin oligodendrocyte glycoprotein antibody-associated disease (MOGAD), acute disseminated encephalomyelitis (ADEM), Idiopathic ON, Idiopathic longitudinally extensive transverse myelitis (LETM) and idiopathic central nervous system (CNS) demyelination are a wide spectrum of primary autoimmune inflammatory demyelinating diseases of the CNS with a wide range of clinical manifestations and yet they share a common immuno-pathogenesis of acquired demyelination. These diseases have a significantly

***Corresponding author:** Dr. Murtaza Noor, Senior Resident, Department of Neurology, Sher-i-Kashmir Institute of Medical Sciences, Soura, Srinagar, Jammu & Kashmir – 190011. Email: murtaza.noor7@gmail.com

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negative impact on the patient's ADLs by causing severe physical disability in the form of motor dysfunction, bladder and bowel impairment, along with severe fatigue and depression. Disability in NMOSD is known to be severe [1] and was found to occur more likely in patients with high initial EDSS and multiple relapses and in such cases there was increased prevalence of visual loss [1, 2].

MOG antibody disease in mixed cohorts was found to be disabling though lesser as compared to NMOSD, but persistence of MOG antibody and the myelitis has been seen to cause severe disability often involving the sphincter functions [3]. In a study [4] on Indian paediatric patients, ADEM were found to have severe disability with mRS between 4 and 6, and in 90.4% of patients there was change to 0-3 at 6 weeks post discharge; adult cases have also been found to present with widespread neurological dysfunction with moderate to severe deficits [5]. 74% of cases of idiopathic LETM were reported to have moderate to severe disability at nadir in one study [6]; and higher EDSS at nadir predicted severe sequelae in another study[7]. The original ONTT data suggested severe visual impairments in idiopathic ON, and were seen to have good outcomes [8], and in comparison the NMOSD-ON was seen be more disabling with no PL [9]; and MOGAD-ON was seen to have a similar or more severe acuity loss but had more relapses [10]. Patients with idiopathic primary large demyelinating lesions presented with significant disability at onset and later showed excellent response to therapywith good functional outcome and rare relapses [11].

Previous studies have primarily focused on clinical features, diagnostic criteria, and therapeutic approaches, with relatively limited attention given to the functional disability profiles of affected patients. While some reports from Western and Asian populations have explored disability outcomes, data from the Indian context remain scarce. Given the unique demographic, cultural, and healthcare-related factors in India, understanding functional impairments in this population is essential for patient-centered management and rehabilitation planning.

Therefore this study aimed to analyse the various functional impairments and disability scores inpatient groups suffering from these diseases and presented to a tertiary care hospital in the Kashmir region of J and K, India, so as to gauge their extent of disability and also compare it with existing cohorts in literature with the ultimate aim of becoming proactive in their early diagnosis and management.

Methodology

A hospital-based, cross sectional study was conducted in the Department of Neurology at Sher-i-Kashmir Institute of Medical Sciences (SKIMS), Srinagar, from October 2022 to June 2024, following approval from the Institute's Ethics Committee. The inclusion criteria included all patients, male and female, aged below or = 18 years and above who met the diagnostic criteria for non-MS inflammatory demyelinating diseases of the CNS including NMOSD, MOGAD, ADEM, as well as idiopathic cases of optic neuritis, LETM, and CNS demyelination. Exclusion criteria included patients of MS, CNS infections causing demyelinating lesions such as progressive multifocal leukoencephalopathy (PML) or HIV, or from alcoholism, BeriBeri, or dyselectrolytemia along with ischemic or toxic demyelination(due to radiation or chemotherapy).

A total of 65 patients who met the inclusion criteria were enrolled in the study after obtaining written informed consent in their vernacular language. Since the prevalence of these diseases in the general population is rare, sample size was only a convenience based and not based on statistical estimation. Each patient initially underwent a detailed clinical evaluation and laboratory investigations, including routine baseline tests and cerebrospinal fluid (CSF) analysis. HIV serology and serum for Aquaporin-4 IgG, anti-MOG antibodies, antinuclear antibodies (ANA), anti-thyroid peroxidase (TPO) antibodies, and anti-Ro and anti-La antibodies was also done; along with Visual evoked responses (VER), BAER (Brainstem Auditory Evoked Responses) and Magnetic resonance imaging (MRI) of the brain, orbits, and spinal cord with contrast (using a 1.5 Tesla superconductive scanner (Magnetom, Skyra, Siemens) to exclude the alternative causes, and to diagnoses and categorise the cases. MRI was done in cases who presented first time and primarily for exclusion of alternative causes and for diagnosis of the said conditions. For cases who had already been diagnosed in the past and had presented either with a relapse or for a follow up, all these investigations including MRI were not repeated.

All data was systematically recorded in a structured proforma, and patients were categorized into specific disease groups based on standardized diagnostic criteria. Once grouped, specific data was then collected on the relapse rate and the various functional impairments which included, the fatigue scores based on the MLIF scale from the ICMR proforma [12] , the depression scores based on the PHQ9 depression scale for adults [13] and RCADS /P scale for the paediatric patients [14], the motor disability scores (based on the

EDSS scores [15] (quantified at the onset and discharge after treatment), the bladder and bowel dysfunction (measured by the standardised bladder [16] and bowel control scales [17] respectively, and a similar paediatric dysfunctional voiding score for children [18]).

The above data quantified the various functional disabilities caused by each group of these diseases. The patients were followed for a short time period till discharge from the hospital, and the motor disability score (i.e., EDSS) was measured again and compared with that at admission (onset or nadir). The paediatric scales are designed as a questionnaire and has parental versions as well, whereby scoring can be done on the basis of questions answered. RCADS and RCADS-P are questionnaire based scales to assess mood changes in a child so as to find the presence an extent of depression and its effect on the day to day activities of living of a child; similarly there is a paediatric dysfunctional voiding scale used as a common scale to score the severity of bladder as well as bowel dysfunction based on multiple questions.

Statistical analysis

Statistical analysis was performed using SPSS software. Continuous variables were summarized as means and standard deviations, while categorical variables were presented as frequencies and percentages. Parametric tests were applied only when the relevant assumptions (normality and homogeneity of variances) were satisfied; otherwise, their appropriate non-parametric analogues were used, whichever was most feasible. Accordingly, one-way analysis of variance (ANOVA) was used to compare means across more than two groups, and when the assumptions of ANOVA were not met, the Kruskal–Wallis test was applied as its non-parametric analogue. For categorical variables, Pearson's χ^2 test was used for group comparisons, and Fisher's exact test was applied when the expected value of any cell was less than 5. All statistical tests were two-tailed, and a *p*-value of less than 0.05 was considered statistically significant. This methodological approach ensured a comprehensive assessment of the functional impairments and disability profiles of patients with non-MS CNS inflammatory demyelinating diseases and allowed for meaningful comparisons and correlations between different disease subtypes.

Results

Table 1 presents the frequency distribution of disease episodes across subtypes. The majority of patients experienced a single episode, most notably in ADEM (88.9%), idiopathic ON (83.3%), LETM (80.0%), and MOGAD (57.1%). Relapsing courses with two or more episodes were more common in seropositive NMOSD (47.6%) and seronegative NMOSD (60.0%), with some patients experiencing up to four episodes. These findings highlight that while monophasic illness predominates in ADEM, idiopathic ON, and LETM, NMOSD is more frequently associated with recurrent episodes.

Table 1: Frequency distribution of number of episodes.

Disease Type	*Episode 1 N (%)*	*Episode 2 N (%)*	*Episode 3 N (%)*	*Episode 4 N (%)*
Seropositive NMOSD	11 (52.4)	6 (28.6)	3 (14.3)	1 (4.8)
Seronegative NMOSD	2 (40.0)	1 (20.0)	2 (40.0)	0 (0.0)
MOGAD	8 (57.1)	5 (35.7)	1 (7.1)	0 (0.0)
ADEM	8 (88.9)	0 (0.0)	0 (0.0)	1 (11.1)
CNS Demyelination	3 (60.0)	2 (40.0)	0 (0.0)	0 (0.0)
Idiopathic ON	5 (83.3)	1 (16.7)	0 (0.0)	0 (0.0)
LETM	4 (80.0)	1 (20.0)	0 (0.0)	0 (0.0)

Table 2 summarizes onset and discharge EDSS scores across different disease types. The mean EDSS at onset was highest in ADEM (7.61 ± 1.43) and seronegative NMOSD (7.10 ± 0.82), followed by seropositive NMOSD (6.67 ± 1.21). Lower onset scores were seen in MOGAD (4.35 ± 3.00), idiopathic ON/LETM (3.63 ± 3.77), and CNS demyelination (3.20 ± 2.08). At discharge, all groups showed improvement, with seropositive NMOSD (3.78 ± 1.10) and ADEM (4.44 ± 2.98) retaining higher disability compared to others. Statistically significant differences in onset ($p < 0.001$) and discharge scores ($p = 0.015$) were observed in seropositive NMOSD, while a significant correlation between onset and discharge EDSS was noted in MOGAD ($r = 0.831$, $p = 0.04$). These findings reflect variability in disease severity and outcomes, with certain subtypes associated with more disabling presentations.

Table 3 shows the distribution of fatigue and depression scores across disease types. The overall fatigue scores were high, with mean values ranging from 5.6 in CNS

demyelination to 7.6 in seronegative NMOSD. Although severe fatigue was reported across groups, differences were not statistically significant (p = 0.443). Depression was also common, with a substantial proportion of patients in each group reporting at least moderate severity. Severe depression was most frequent in ADEM (22.2%) and seropositive NMOSD (19.0%). However, the distribution of depression scores across disease types did not reach statistical significance (p = 0.664). Although not statistically significant, the presence of fatigue and depression in patients with non-MS demyelinating diseases is clinically important, as both symptoms can substantially affect quality of life, functional independence, treatment adherence, and long-term outcomes. Recognizing these domains highlights the need for early psychological and supportive interventions alongside disease-specific therapy.

Table 2: Onset and discharge EDSS with correlation coefficient across disease types.

Disease Type	*n*	*Onset EDSS (Mean ± SD)*	*Min–Max (Onset)*	*p-value (Onset)*	*Discharge EDSS (Mean ± SD)*	*Min–Max (Discharge)*	*p-value (Discharge)*
Seropositive NMOSD	21	6.67 ± 1.21	3.5–8.5	<0.001	3.78 ± 1.10	1.5–6.5	0.015
Seronegative NMOSD	5	7.10 ± 0.82	6.5–8.0		3.40 ± 0.65	2.5–4.5	
MOGAD	14	4.35 ± 3.00	0–8.0		2.53 ± 1.56	0–5.5	
ADEM	9	7.61 ± 1.43	4.5–9.5		4.44 ± 2.98	1.0–9.5	
CNS Demyelination	5	3.20 ± 2.08	1.0–6.0		3.00 ± 2.03	1.0–5.5	
Idiopathic ON/LETM	11	3.63 ± 3.77	0–9.5		1.81 ± 2.01	0–7.5	

Table 3: Fatigue and depression score distribution across disease types.

Disease Type	*n*	*Fatigue Score (Mean ± SD)*	*Min–Max Fatigue*	*p-value (Fatigue)*	*Mild Depression (5–9) N (%)*	*Moderate Depression (10–14) N (%)*	*Moderately Severe (15–19) N (%)*	*Severe (≥20) N (%)*	*p-value (Depression)*
Seropositive NMOSD	21	7.29 ± 1.10	5–9	0.443	7 (33.3)	6 (28.6)	4 (19.0)	4 (19.0)	0.664
Seronegative NMOSD	5	7.60 ± 0.55	7–8		2 (40.0)	2 (40.0)	1 (20.0)	0 (0.0)	
MOGAD	14	6.36 ± 2.21	0–9		7 (50.0)	2 (14.3)	3 (21.4)	1 (7.1)	
ADEM	9	7.00 ± 2.44	2–10		5 (55.6)	1 (11.1)	1 (11.1)	2 (22.2)	
CNS Demyelination	5	5.60 ± 3.28	0–8		2 (40.0)	2 (40.0)	1 (20.0)	0 (0.0)	
ON/LETM	11	6.82 ± 2.04	4–10		8 (72.7)	2 (18.2)	0 (0.0)	1 (9.1)	

Table 4 presents bladder and bowel control scores across disease types. Severe bladder dysfunction was most frequent in idiopathic LETM (80.0%), ADEM (66.7%), and seronegative NMOSD (60.0%), while seropositive NMOSD also showed a high burden (52.4%). In contrast, MOGAD and CNS demyelination cases predominantly reported mild to moderate dysfunction, and idiopathic ON showed no impairment. A similar pattern was observed for bowel control, with severe dysfunction in idiopathic LETM (60.0%), ADEM (55.6%), and seropositive NMOSD (42.9%), whereas MOGAD, CNS demyelination, and idiopathic ON demonstrated mostly mild impairment. The differences in bladder and bowel scores across groups were statistically significant (p < 0.001 for both). These findings underscore the higher disability burden in specific subtypes, particularly NMOSD, LETM, and ADEM.

Discussion

Non-MS inflammatory CNS diseases are highly disabling and cause severe functional impairments like fatigue, depression, motor disability and bladder bowel dysfunction. They can be monophasic or relapsing in nature. The study examined the number of episodes across various disease types, NMOSD was found to have a relapsing phenotype in nearly half of the cases and so was the case in MOGAD, this was in stark contrast to the ADEM and other idiopathic cases which were strictly monophasic in nature in our study, Wingerchuk

Table 4: Bladder and bowel control score distribution across disease types.

Disease Type	*Bladder Control Mild (0–7) N (%)*	*Bladder Control Moderate (7–15) N (%)*	*Bladder Control Severe (16–22) N (%)*	*p-value (Bladder)*	*Bowel Control Mild N (%)*	*Bowel Control Moderate N (%)*	*Bowel Control Severe N (%)*	*p-value (Bowel)*
Seropositive NMOSD	1 (4.8)	9 (42.9)	11 (52.4)		6 (28.6)	6 (28.6)	9 (42.9)	
Seronegative NMOSD	0 (0.0)	2 (40.0)	3 (60.0)		2 (40.0)	1 (20.0)	2 (40.0)	
MOGAD	5 (35.7)	8 (57.1)	1 (7.1)		8 (57.1)	6 (42.9)	0 (0.0)	
ADEM	2 (22.2)	1 (11.1)	6 (66.7)	<0.001	2 (22.2)	2 (22.2)	5 (55.6)	<0.001
CNS Demyelination	5 (100.0)	0 (0.0)	0 (0.0)		5 (100.0)	0 (0.0)	0 (0.0)	
Idiopathic LETM	0 (0.0)	1 (20.0)	4 (80.0)		2 (40.0)	0 (0.0)	3 (60.0)	
Idiopathic ON	6 (100.0)	0 (0.0)	0 (0.0)		6 (100.0)	0 (0.0)	0 (0.0)	

et al [19]has reported that NMOSD has a monophasic as well as a relapsing nature as was seen in our study, for MOGAD, Tatsuroet al [20] reported that MOGAD cases can have a relapsing course with recurrent episodes in nearly 50 % of patients and similar findings were reported by Coboet al [21]. ADEM has been reported to be a monophasic course by Mukhtiaretal [22], Xiongetal [23], consistent with our findings, Pavone et al [24] also has reported a monophasic course in majority of its cohort. Idiopathic ON and idiopathic LETM have been reported as monophasic illnesses in majority of their casesby Cobo et al [25].

As per a study by Rocchi et al [26], relapses were less common in cases of idiopathic myelitis and similar result was reported regarding idiopathic ON by Ambika et al [27]. Consistent with our findings Tobin et al [28] reported that 60 % cases of idiopathic CNS inflammatory demyelination having a monophasic course and similar results have been reported in another recent study from Thialand [29] (57.7% monophasic illness). EDSS was used to measure the motor disability providing crucial information regarding the initial severity of the disease. NMOSD cases had a mean EDSS of 6.67 (3.5-8.5) in seropositive cases and 7.10 (6.5-8.0) in sero-negative cases; Mealy et al [30] while reporting on the effects of NMOSD on the quality of life showed that the mean EDSS score was 5.0 ± 1.8 of the 24 cases studied, aligning with our study suggesting the disabling nature of this disease. MOGAD cases showed a mean EDSS of 4.35 (0-8.0) at onset; in acute phase MOGAD cases reported by Cobo et al [7] reported a median EDSS of 4.0 (1.0-9.0), similarly Xu et al [31] reported a median EDSS at onset of 3.5 (2.50-4.00) as consistent with our findings. The mean EDSS of ADEM cases (7.61) with similar reports by Iype et al [32] (6.28). Our cases of idiopathic primary CNS demyelination had a mean EDSS OF 3.20 (1-6.0) similar to reports by Tobin et al [28] (3.5) in patients of CNS demyelination not fitting into other groups and by study from Thailand [29](4.3 was the average EDSS). In nutshell, idiopathic LETM and idiopathic ON, the mean EDSS at onset was 3.63, with a maximum of 9.5, with a drop to mean of 1.81 at discharge.

The mild motor disability is contributed from cases of idiopathic ON as such conditions don't cause motor disability, the severe dysfunction is contributed from cases of idiopathic LETM, showing significant disability at discharge also; Zhou et al [33] reported a mean EDSS of 4.5 (2-8) in idiopathic LETM cases at onset and of 1.5 at follow up. Though the differences between EDSS among disease types and also between EDSS at onset and at discharge was all significant , we need a large longitudinal cohort study to look for a correlation between EDSS at onset and on a reasonable follow up. A significant amount of fatigue was reported by our patients of CNS demyelination in nearly all groups. Fatigue has been reported as an important and disabling symptom of NMOSD by MecaLallana et al [34]; in more than 40 % of cases causing moderate to severe disability, with similar reports by Beekman et al [35].

A higher percentage of MOG patients were reported to have severe fatigue in a study reported by Ladakis et al [36] (75.6%). Leontien et al [37] reported that children suffering from ADEM were found to be significantly fatigued despite having a lower EDSS. Milder degrees of fatigue was found in our studied groups of idiopathic CNS demyelination, idiopathic ON, and idiopathic LETM, with no current corroborations from the literature. In our study severe depression was reported by 19 % cases of NMOSD, 22.2% cases of ADEM, 7.1% cases of MOGAD and in 9.09% cases of idiopathic LETM. Zeng et al [38] reported a diagnosis of depression in 28.81% cases of NMOSD; Susanna et al [39] reported 23.2%cases in their study on MOGAD patients to be suffering from moderate

to severe depression, and a similar study noted elevated levels of depression in ADEM[40]. Beekman et al [41] has reported a significant bladder dysfunction in 26.4% cases and bowel dysfunction in 15.5% of cases of NMOSD, comparatively our study has reported a severe dysfunction in double the number of cases. Similar to our findings, Viven Li et al [42] reported bladder and bowel dysfunction in MOGAD patients (55% and 36% respectively). JN Panicker et al [43] reported LUTD in 40 (5 cases of ADEM). Zhou et al [33] reported bladder and bowel dysfunction in 43.9% cases in the poor prognostic groups of idiopathic LETM in commonality with our cases.

Cases of idiopathic primary CNS demyelination in our study had a very mild degree of bladder and bowel dysfunction in all patients, the Thailand study [29] on seronegative cases of tumefactive demyelinating lesions reported such dysfunction in only 1 case out of 25 in the cohort (4%). Overall bladder and bowel functional dysfunction are a significant issue in these demyelinating CNS diseases, and our study reports a severe and very prevalent dysfunction in nearly all of these groups, which was comparatively higher than what is seen in existing literature probably because of late presentation and unexplored genetic predisposition.

Limitations and future prospects: the limited sample size and the mixed nature of the cohort precludes any robust statistical analyses. This is especially true for aspects like fatigue and depression scores; though such impairments were found to affect a good number of such patients; but they were not seen to be statistically significant when compared with number of episodes and increasing severity of the disease, a higher sample size in each group might clarify such associations. Also the short duration of the follow up until discharge again precludes a significant statistical correlation. The study analysed may have been affected by referral bias being a part of a tertiary care hospital and the self-reported questionnaires of fatigue and depression may have been influenced by cultural factors. Hence a large scale study with a larger sample size and a longer longitudinal follow up and use of standardised scales would improve upon the above limitations.

Conclusion

CNS demyelinating conditions by virtue of spinal cord and other CNS dysfunction cause significant amount functional impairment and disability across multiple domains, particularly in the acute phase. This study reports a more severe sphincter and motor dysfunction in this cohort compared to other domains like fatigue and depression. EDSS was shown to improve over a short follow up till discharge, highlighting early recognition and treatment, however larger longitudinal studies are needed to confirm long term disability trajectories.

Conflicts of interest

Authors declare no conflicts of interest.

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