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TO EVALUATE THE ROLE OF MRI IN DETECTING AND MONITORING SPINAL CORD LESIONS IN PATIENTS DIAGNOSED WITH MULTIPLE SCLEROSIS

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Abstract

Background: *Multiple Sclerosis (MS) is a chronic autoimmune disease affecting the central nervous system, where spinal cord involvement is both diagnostically and prognostically significant. MRI plays a vital role in visualizing demyelinating lesions and assessing disease progression.*

Objective: *To evaluate the role of MRI in detecting and monitoring spinal cord lesions in patients diagnosed with multiple sclerosis.*

Methodology: *This cross-sectional study was conducted over three months at Shaikh Zayed Medical College and various tertiary care hospitals in Punjab. A total of 102 clinically confirmed MS patients aged 18–80 years, who had undergone spinal MRIs, were included using a non-probability purposive sampling technique. Patients with tumors, trauma, or contraindications to MRI were excluded.*

Results: *Among 102 MS patients, ataxia (34.3%) was the most prevalent primary symptom, followed by optic neuritis (26.5%) and leg weakness (21.6%). Most patients (52.0%) were above 50 years of age, with a nearly equal gender distribution (51.0% female, 49.0% male). MRI revealed cervical lesions in 72.5%, thoracic lesions in 81.4%, and lumbar lesions in 39.2%. Regarding disability, 30.4% had moderate, 24.5% mild, 15.7% severe, and 29.4% had no disability. Lesion activity indicated 33.3% stable, 24.5% mixed, 23.5% chronic, and 18.6% active lesions. Diagnostically, 30.4% were SPMS, 25.5% PPMS, 12.7% RRMS, and 31.4% fell into other subtypes. Cervical and thoracic lesions were consistently observed across age groups, with thoracic involvement being universal (100%) among younger patients aged 20–35 years.*

Conclusion: *MRI is a highly effective tool for detecting and monitoring spinal cord lesions in MS, revealing significant lesion burden even in early and less symptomatic stages. The high prevalence of cervical and thoracic lesions across all age groups, particularly among younger patients, underscores MRI's utility in timely diagnosis and disease stratification. These findings reinforce MRI's role as a cornerstone in MS management and prognosis assessment.*

INTRODUCTION

Multiple Sclerosis (MS) is a mysterious and troublesome neurological disease in medical professionals and researchers have been trying to figure out of many years. This long-term

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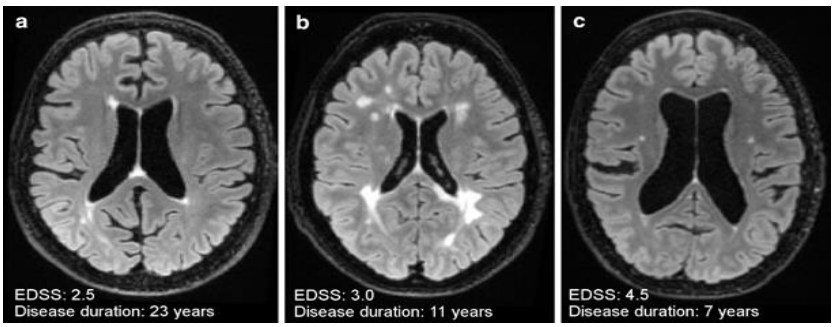
autoimmune disease mainly attacks the central nervous system (CNS), inflicting a trail of destruction in the process. The truth is, MS involves the immune system of the human body making a mistake by the nerve fibers that are important to the body by destroying the protective myelin sheath, which is described as demyelination (1). The outcomes of the demyelinating autoimmune injury are widespread and frequently catastrophic. The myelin sheath, in its degeneration process, hinders the normal conduction of electrical signals transmitted through the nerve fibers, generating a broad spectrum of neurological symptoms. Furthermore, the injuries are not confined to myelin only; MS may also fundamentally damage the neurons, leading often to irretrievable neuronal death (1, 2).

This combined exacerbation of myelin and neurons underpins the disease's progressive course and the concomitant disability increase over time. One of the body parts that are affected most in MS is the spinal cord, which is a vital part of the central nervous system. The nerves that are distributed throughout the body get messages from the brain by the spinal cord, which plays the major part in that, it also transmits and controls important things like movement, sensation, and some autonomic processes (3). When MS plaques appear in the spinal cord, they may lead to a whole set of mobility problems and neurological disorders. These symptoms may include weakness, numbness, tingling sensations, and difficulties with coordination and balance, often leading to significant challenges in daily activities and independence (4).

Magnetic Resonance Imaging (MRI) is one of the most powerful diagnostic tools that is tailored and specific to neuroimaging and within Multiple Sclerosis. It is a non-invasive imaging technique that uses magnetic fields and radio waves to make images of the body's internal structures, which provides immense knowledge of the central nervous system (5). When we talk about MS, MRI has already become the gold standard in the area of diagnosis provoked by its outstanding capability to detect white matter lesions, which is the marker of the disease (5, 6). These lesions are indicative of demyelination areas and inflammation; they occur as evident bright spots only in certain MRI sequences, which are the main source of proof for activity and progression of the disease (6). MRI's role in identifying spinal cord lesions, otherwise often overlooked, is among the strengths of this tool in diagnosing MS which has the capability to be a showstopper. A spinal MRI really plays a crucial role in complementing the brain imaging by identifying those asymptomatic spinal cord lesions that might have been missed if only the brain had been examined(6). This holistic approach indeed leads to an improved diagnostic accuracy and gives a more detailed view of the distribution and severity of the disease(7). In specific, spinal MRI is of particular value as it is able to reveal asymptomatic spinal cord lesions that might be omitted from brain imaging alone. Research has revealed that approximately 25 % of clinically stable relapsing-remitting MS patients develop these lesions within 14-17 months(8). Asymptomatic spinal lesions have a significant prognostic value, so they are associated with the risk of further relapses and magnetic imaging activity. Furthermore, spinal MRI is helpful to exclude other diseases such as malignancies or spinal stenosis when the result of brain imaging is doubtful(9). Beyond diagnosis, MRI has a major role in tracking disease activities, evaluating the effectiveness of treatments, and making clinical decisions in both everyday practice and research applications(10).



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In figure three axial fluid attenuated inversion recovery (FLAIR) images illustrating the clinico-radiological paradox of multiple sclerosis: **a** 52-year-old male (benign) relapsing remitting multiple sclerosis (RRMS) patient, disease duration of 23 years, expanded disability status scale (EDSS) score of 2.5; **b** 50-year-old female RRMS patient, disease duration of 11 years, EDSS score of 3.0, **c** 53-year-old female primary progressive multiple sclerosis (PPMS) patient, disease duration of 7 years, EDSS of 4.5.

Multiple Sclerosis (MS) has mainly centered on brain lesions, resulting in a major knowledge gap in the role of spinal cord in the disease. Although the brain MRI has been the area of most knowledge and practice of MS diagnosis and monitoring, the contribution of the spinal cord and its imaging findings have been left unassumed(9). The thorough examination of neural pathways in the spinal cord in MS among some populations is a clear problem, particularly the Pakistani population and its neighbouring countries (9, 11). The study will determine the most prevalent results, such as lesion distribution and progression over time, by assessing how well MRI diagnoses and monitors spinal cord alterations in multiple sclerosis. The findings will have a major impact on increasing the precision of diagnoses, directing clinical judgements, and eventually improving patient outcomes.

Results

Table 1: Frequency Distribution

Variable	Category	Frequency	Percent
Symptoms	Leg weakness	22	21.6%
	Optic neuritis	27	26.5%
	Ataxia	35	34.3%
	Visual disturbances	18	17.6%
Age	20–35 years	14	13.7%
	36–50 years	35	34.3%
	>50 years	53	52.0%
Gender	Male	50	49.0%
	Female	52	51.0%
Cervical Cord Lesion	Absent	28	27.5%
	Present	74	72.5%
Thoracic Cord Lesion	Absent	19	18.6%
	Present	83	81.4%
Lumbar Cord Lesion	Absent	62	60.8%
	Present	40	39.2%
Disability Level	None	30	29.4%
	Mild	25	24.5%
	Moderate	31	30.4%
	Severe	16	15.7%
Lesion Activity	Active Lesion	19	18.6%
	Chronic Lesion	24	23.5%
	Mixed Lesion	25	24.5%
	Stable	34	33.3%
Final Diagnosis	RRMS (Relapsing MS forms)	13	12.7%
	PPMS (Primary Progressive MS)	26	25.5%
	SPMS (Secondary Progressive MS)	31	30.4%
	Others	32	31.4%

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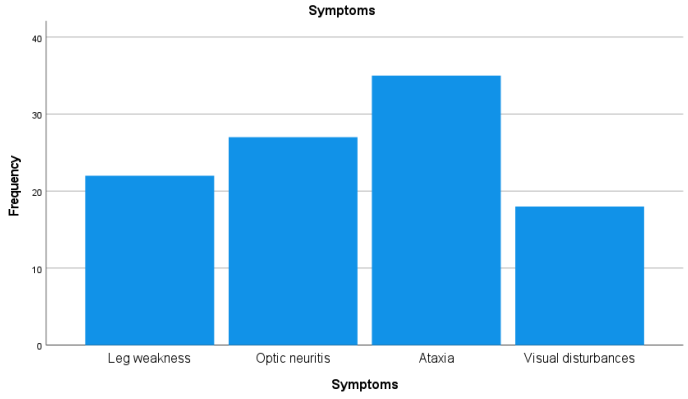
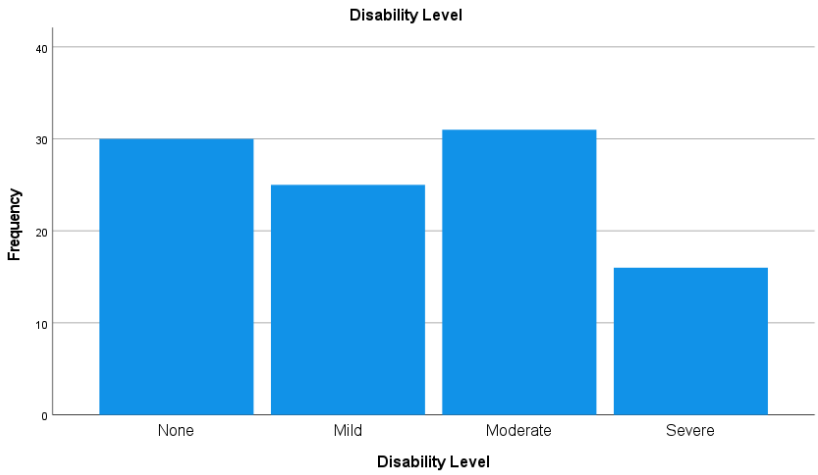
Table Number: 02

Age Group	Cervical Cord Lesion Absent	Cervical Cord Lesion Present	Total
20–35 years	3	11	14
36–50 years	9	26	35
>50 years	16	37	53
Total	28	74	102

Table Number: 03

Age Group	Thoracic Cord Lesion Absent	Thoracic Cord Lesion Present	Lumbar Cord Lesion Absent	Lumbar Cord Lesion Present	Total
20–35 years	0	14	9	5	14
36–50 years	6	29	20	15	35
>50 years	13	40	33	20	53
Total	19	83	62	40	102





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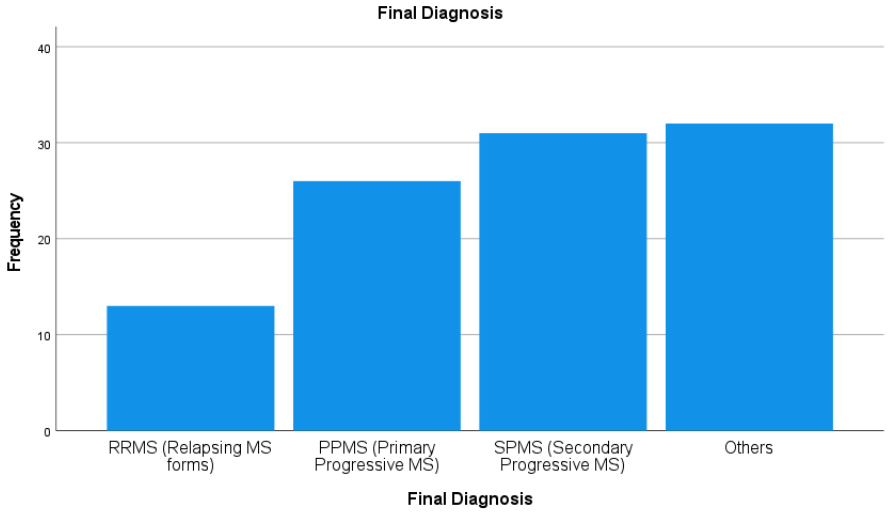

Results

In a study 102 patients with multiple sclerosis (MS), the distribution of primary symptoms was as follows: ataxia was the most common symptom, reported in 34.3% of cases, followed by optic neuritis in 26.5%, leg weakness in 21.6%, and visual disturbances in 17.6%. Regarding age distribution, more than half (52.0%) of the patients were older than 50 years, 34.3% were between 36 and 50 years old, and 13.7% were between 20 and 35 years old. The gender distribution was relatively balanced, with 51.0% females and 49.0% males.

MRI findings showed a high frequency of spinal cord involvement: cervical cord lesions were present in 72.5% of patients, thoracic cord lesions in 81.4%, and lumbar cord lesions in 39.2%. For disability levels, 29.4% of patients had no disability, 24.5% had mild disability, 30.4% had moderate disability, and 15.7% had severe disability. Lesion activity assessment revealed that 33.3% of patients had stable lesions, 24.5% had mixed active and chronic lesions, 23.5% had chronic lesions, and 18.6% had active lesions. When analyzing the final diagnosis categories, 30.4% of the patients were diagnosed with Secondary Progressive MS (SPMS), 25.5% with Primary Progressive MS (PPMS), 12.7% with Relapsing-Remitting MS (RRMS), and 31.4% were categorized under "others" including pediatric MS, clinically isolated syndrome, and transverse myelitis.

Cross-tabulation analysis between age groups and cervical cord lesions showed that among patients aged 20–35 years, 78.6% had cervical lesions; among those aged 36–50 years, 74.3% had cervical lesions; and among those over 50 years, 69.8% had cervical lesions. Similarly, thoracic cord lesions were highly prevalent across all age groups, especially in younger patients (100% of 20–35 years group had thoracic lesions). Lumbar cord lesions were less common, seen in 35.7% of the 20–35 age group, 42.9% of the 36–50 group, and 37.7% of those above 50 years.

Discussion

This study highlights the pivotal role of MRI in detecting and monitoring spinal cord lesions among multiple sclerosis (MS) patients. A high prevalence of spinal cord involvement was observed, with cervical and thoracic lesions being most common. These findings align with previous research emphasizing that spinal cord lesions are critical markers of disease severity and progression.Ataxia was the most frequent primary symptom in our cohort (34.3%), followed by optic neuritis and leg weakness. This symptom pattern is supported by a study by Oh et al. (2019), who found that motor deficits and sensory symptoms are the most common clinical presentations in spinal cord MS involvement, with optic neuritis commonly preceding other manifestations (Oh, J., Vidal-Jordana, A., & Montalban, The balanced gender distribution (51% female, 49% male) slightly differs from typical MS demographics, where female predominance is more significant (around 2–3:1) (Harbo, H. F., Gold, R., & Tintore, . This variation may reflect sampling variation or specific regional epidemiology.

The frequency of cervical cord lesions (72.5%) and thoracic cord lesions (81.4%) in our study is

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consistent with earlier findings indicating that the cervical and thoracic spinal cords are the most common sites for demyelinating lesions. Naismith et al. (2012) demonstrated a similar pattern, with cervical spinal cord lesions reported in 60–80% of MS patients, significantly contributing to disability (Naismith, et al., 2012). Lumbar lesions were less prevalent (39.2%) in our cohort, which is also consistent with prior studies suggesting that lumbar involvement is relatively rare due to the smaller amount of white matter in the lumbar spinal cord (Kearney, et al., 2015). The assessment of lesion activity indicated that stable lesions were most common (33.3%), followed by mixed and chronic lesions. This distribution mirrors findings by Rocca et al. (2017), who reported that chronic and mixed lesions dominate in progressive forms of MS, while active lesions are more prominent in early stages (Rocca, , et al., 2017). Regarding the final diagnosis, Secondary Progressive MS (SPMS) was the most common subtype (30.4%), followed by Primary Progressive MS (PPMS) (25.5%). These results resonate with the natural history of MS, where a significant proportion of patients with relapsing-remitting MS (RRMS) transition to SPMS over time (Lublin,et al ., 2010)

The cross-tabulation analysis further emphasized that cervical and thoracic lesions are prevalent across all age groups, with younger patients (20–35 years) showing particularly high rates of thoracic lesions (100%). This trend suggests that aggressive spinal cord involvement may begin early in the disease course, as noted by Dupuy et al. (2015), who discussed early spinal cord MRI findings predicting faster disability accumulation (Dupuy, et al., 2015). Overall, the findings of this study strengthen the existing evidence that MRI-detected spinal cord lesions are critical not only for diagnosis but also for predicting clinical outcomes and tailoring therapeutic interventions in MS.

Conclusion

MRI is a highly effective tool for detecting and monitoring spinal cord lesions in MS, revealing significant lesion burden even in early and less symptomatic stages. The high prevalence of cervical and thoracic lesions across all age groups, particularly among younger patients, underscores MRI's utility in timely diagnosis and disease stratification. These findings reinforce MRI's role as a cornerstone in MS management and prognosis assessment.

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