

Vestibular dysfunction and infratentorial MRI abnormalities in multiple sclerosis

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Abstract

Aims

To determine the prevalence of vestibular symptoms in people with multiple sclerosis (pwMS) and to examine associations with infratentorial MRI abnormalities.

Methods

We conducted a cross-sectional study of pwMS attending a university hospital, using a self-report questionnaire to assess vestibular symptoms. MRI brain scans were analysed for (i) active T2 lesions, (ii) middle cerebellar peduncle (MCP) lesion count, and (iii) total infratentorial lesion count. Associations with symptoms were tested using Chi-squared analysis.

Results

Eighty pwMS participated with a mean age 46.1 ± 13.9 years, 64 female (80%), and 64 (80%) had relapsing remitting MS. Vestibular symptoms were identified in 74 participants (92.5%), including imbalance, vertigo, and dizziness most frequently reported. No associations were observed between symptoms and active lesions or MCP lesion counts. However, infratentorial lesion burden was significantly associated with head motion intolerance ($p = 0.007$).

Conclusion

Vestibular symptoms are common in pwMS yet frequently under-recognised. Our findings highlight the clinical relevance of infratentorial lesion counts, a routinely available MRI metric, in identifying patients at risk of vestibular dysfunction. Early referral to vestibular rehabilitation in patients with high infratentorial lesion burden may help reduce falls and improve quality of life.

Introduction

Multiple sclerosis (MS) is a chronic inflammatory disease of the central nervous system (CNS)¹. MS produces focal white and grey matter lesions, characterised by demyelination, oligodendrocyte loss, and variable axonal damage². Lesion location and severity account for the wide spectrum of clinical presentations and disability.

Vestibular symptoms are common in people with MS (pwMS)³. Vestibular dysfunction is seen more often in pwMS compared with controls. Abnormal posturography is also observed, increasing fall risk³. Beyond distress, unrecognised or untreated vestibular symptoms contribute to falls and fractures in a population already vulnerable to reduced bone health⁴.

MRI brain scans are central to MS diagnosis⁵ and disease monitoring⁶, but may also provide additional clinical insights. Active T2 lesions have been linked with severe audiovestibular symptoms^{7,8}. Higher brainstem and middle cerebellar peduncle (MCP) lesion loads have been associated with recurrent falls and impaired balance⁸.

The infratentorial region contains numerous brainstem nuclei and white matter tracts that coordinate head and eye movements, while the cerebellar peduncles transmit cerebellar balance regulation. Lesions here may therefore underlie vestibular dysfunction.

Recent evidence suggests vestibular rehabilitation is effective in MS, including via technology-assisted approaches⁹. Given that vestibular symptoms are often under-reported, and that routine MRI metrics may reflect these symptoms, we investigated their prevalence in pwMS and associations with MCP and infratentorial lesions.

Methods

The study was approved by the St James's Hospital/Tallaght University Hospital Joint Research Ethics Committee (Ref No 146) and conducted in accordance with the Declaration of Helsinki. All participants gave written informed consent.

PwMS attending neurology and physiotherapy clinics were invited. We recruited participants from both clinics with a higher proportion from physiotherapy (75%). All people diagnosed with MS are referred to physiotherapy in our centre at the point of diagnosis, irrespective of baseline presentation. Inclusion criteria were: (i) confirmed MS diagnosis⁵, (ii) attendance at the MS clinic, and (iii) capacity to provide consent. Exclusion criteria included age <18, other vestibular disease, recent relapse or therapy change (within three months), acute medical illness, pregnancy, or active benign paroxysmal positional vertigo. Disability was assessed with the Expanded Disability Status Scale (EDSS)¹⁰. Use of mobility aids, falls history, and fear of falling were also recorded.

A cross-sectional survey developed by the research team was performed using a structured questionnaire covering five symptoms: dizziness, vertigo, head motion intolerance, oscillopsia, and imbalance. Presence and severity (0–10 scale) were recorded, alongside demographics, disease type/duration, and falls history.

The most recent MRI (within one year of survey) was analysed. Three MRI metrics were assessed: (i) active lesions (new or enlarging T2 lesions on radiologist report), (ii) MCP lesion count, and (iii) infratentorial lesion count. Lesions were defined as focal hyperintensities on both axial T2 and FLAIR sequences, following MAGNIMS guidelines^{6, 11}.

Associations between MRI metrics and vestibular symptoms were tested using Chi-squared analysis, with significance set at $p < 0.05$. No correction for multiple comparisons was applied given the a priori hypotheses¹². Analyses were performed with SPSS v29.

Results

Eighty pwMS completed the prevalence survey. Mean age was 46.1 years (± 13.9); 80% were female. Mean disease duration was 12 years (± 10.8). The majority had relapsing-remitting MS (RRMS, 81.3%), with smaller proportions of secondary-progressive (SPMS, 13.8%) and primary-progressive MS (PPMS, 5%). Median EDSS was 2 (range 0–8), with a mean of 2.7 (standard deviation ± 2.2) indicating that the majority of the participants had low level of physical disability recorded on this scale and the minority (21%) had an EDSS ≥ 5 . Twenty-seven patients used mobility aids, but did not use these continuously and could walk unaided for more than 500m but used their aid in settings where they felt more at risk of falling or in situations resulting in lower levels of confidence in their physical ability or owing to fluctuations in their neurological function. In total, 40% reported a fall in the past year, and 34% reported fear of falling.

Vestibular symptoms were present in 92.5% of participants. Imbalance, vertigo, and dizziness were most frequent, while head motion intolerance and oscillopsia were less common. Mean number of symptoms per patient was 2.8 (± 1.5). Most (71.6%) reported recurrent attacks, while 8.6% reported single attacks. Symptom frequency ranged from daily to less than monthly. Mean symptom severity was 4.1 (± 2.9) on a 0–10 scale.

Sixty patients had suitable MRI scans within 12 months. Active lesions were reported in 18.3%. MCP lesions were uncommon: 65% had none, 30% had 1–2, and one patient had 3. Infratentorial lesions were more frequent: 73% had ≥ 1 , with 12% showing > 5 lesions.

Chi-squared analysis showed no significant association between vestibular symptoms and active or MCP lesions. However, infratentorial lesion burden was significantly associated with

head motion intolerance (93% of patients with this symptom had infratentorial lesions vs. 56% without; $p = 0.007$). Other symptoms showed no statistically significant associations.

Bland–Altman analysis demonstrated good reproducibility for lesion counts. MCP counts showed a mean difference of 0.1 (SD 0.3) between readers; infratentorial counts a mean difference of 1 (SD 1.8).

Discussion

This study confirms that vestibular symptoms are highly prevalent in pwMS, with over 90% of participants reporting dysfunction. Symptoms such as imbalance, vertigo, dizziness, oscillopsia, and head motion intolerance not only impair quality of life but also increase fall risk^{13, 14}.

We found a significant association between infratentorial lesion burden and head motion intolerance. Given the density of vestibular nuclei and tracts in this region, such lesions may disrupt pathways essential for balance, gaze stability, and motor coordination. These findings suggest that routine assessment of infratentorial lesion counts could aid clinicians in identifying patients at risk of vestibular dysfunction.

Clinical implications include the potential for earlier referral to vestibular rehabilitation, which has proven benefits for balance, dizziness, and fatigue^{14–18}. This is especially relevant as fear of falling is common in MS¹⁹ and may limit participation in exercise, an important disease-modifying lifestyle factor.

Limitations include recruitment bias, as many participants were referred via physiotherapy, although pwMS are universally referred to physiotherapy in our centre which may offset this potential bias. Secondly, the reliance on conventional MRI, which lacks sensitivity for diffuse or cortical pathology. Third, vestibular function testing and fatigue assessment were not performed, which may have provided further insights^{20–22}. Fourth, cognitive impairment, which may influence questionnaire reliability, was also not formally assessed. Lastly, we did not record hormonal status such as menopause in the women recruited, which may influence the symptoms of vertigo.

Overall, our results highlight the importance of considering infratentorial MRI abnormalities when evaluating vestibular symptoms in MS. This readily available metric may guide timely rehabilitation and help reduce fall risk.

Declarations of Conflicts of Interest:

None declared.

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Appendix:

	Subcategories	Frequency	Percent (%)
Vestibular Symptoms	Yes	74	92.5
	No	6	7.5
Vertigo	Yes	50	62.5
	No	30	37.5
Dizziness	Yes	51	63.7
	No	29	36.3
Oscillopsia	Yes	26	32.5
	No	54	67.5
Imbalance	Yes	63	78.8
	No	17	21.3
Head Motion Intolerance	Yes	37	46.3
	No	43	53.8
Attack Type	NA	16	19.8
	Single	7	8.6
	Recurrent	58	71.6
Frequency of Symptoms	NA	8	9.9
	Daily	8	9.9
	1-3 times/week	17	21
	Once per fortnight	9	11.1
	Once per month	9	11.1
	> than once per month	22	27.2

Table 1: Results from the prevalence study showing the frequencies reported by the cohort of people with MS with vestibular symptoms. The results displayed highlight the majority of people had symptoms of imbalance.

Symptoms	Presence	ITR Lesions	MCP Lesions	% of pwMS with ITR Lesions	% of pwMS with MCP Lesions
Vertigo	Yes (41)	33	11	80%	27%
	No (19)	16	4	84%	21%
Dizziness	Yes (38)	31	16	82%	42%
	No (22)	13	5	59%	22%
Oscillopsia	Yes (22)	17	5	77%	23%
	No (38)	27	16	71%	42%
Imbalance	Yes (47)	36	18	77%	38%
	No (13)	7	3	54%	23%
Head Motion Intolerance	Yes (28)	26	13	93%	46%
	No (32)	18	8	56%	25%

Table 2: The presence of vestibular symptoms and the frequency of infratentorial and middle cerebellar peduncle lesions seen on MRI brain.

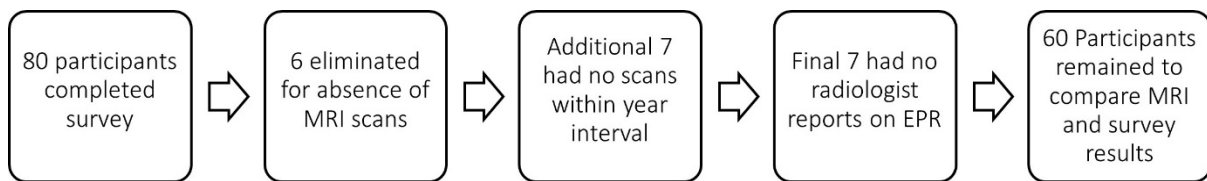


Figure 1: Flow chart of cases excluded from MRI analysis from vestibular prevalence component of the study.

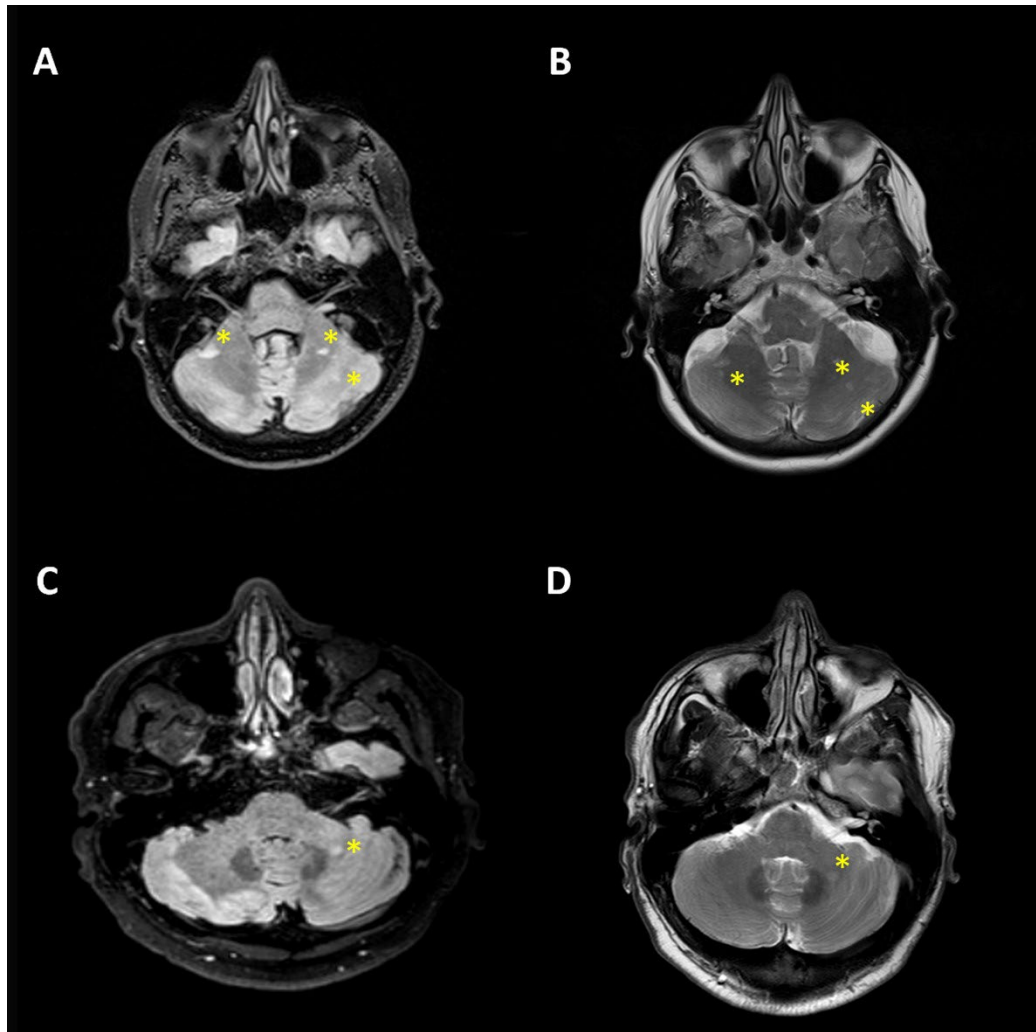


Figure 2: Image (A) demonstrating examples of infratentorial lesions on axial FLAIR and corresponding abnormalities seen on (B) axial T2-weighted image. MS lesions are denoted by yellow asterisk. In image (C) an example of a middle cerebellar peduncle lesion is shown, also highlighted by yellow asterisk with the corresponding abnormality seen in (D) an axial T2-weighted scan. Patient in images (A) and (B) reported imbalance. They had no fall history in the year prior but reported a fear of falling. The patient in images (C) and (D) reported vertigo, dizziness, oscillopsia and head motion intolerance. They had a falls history within the previous year but did not report a fear of falling.