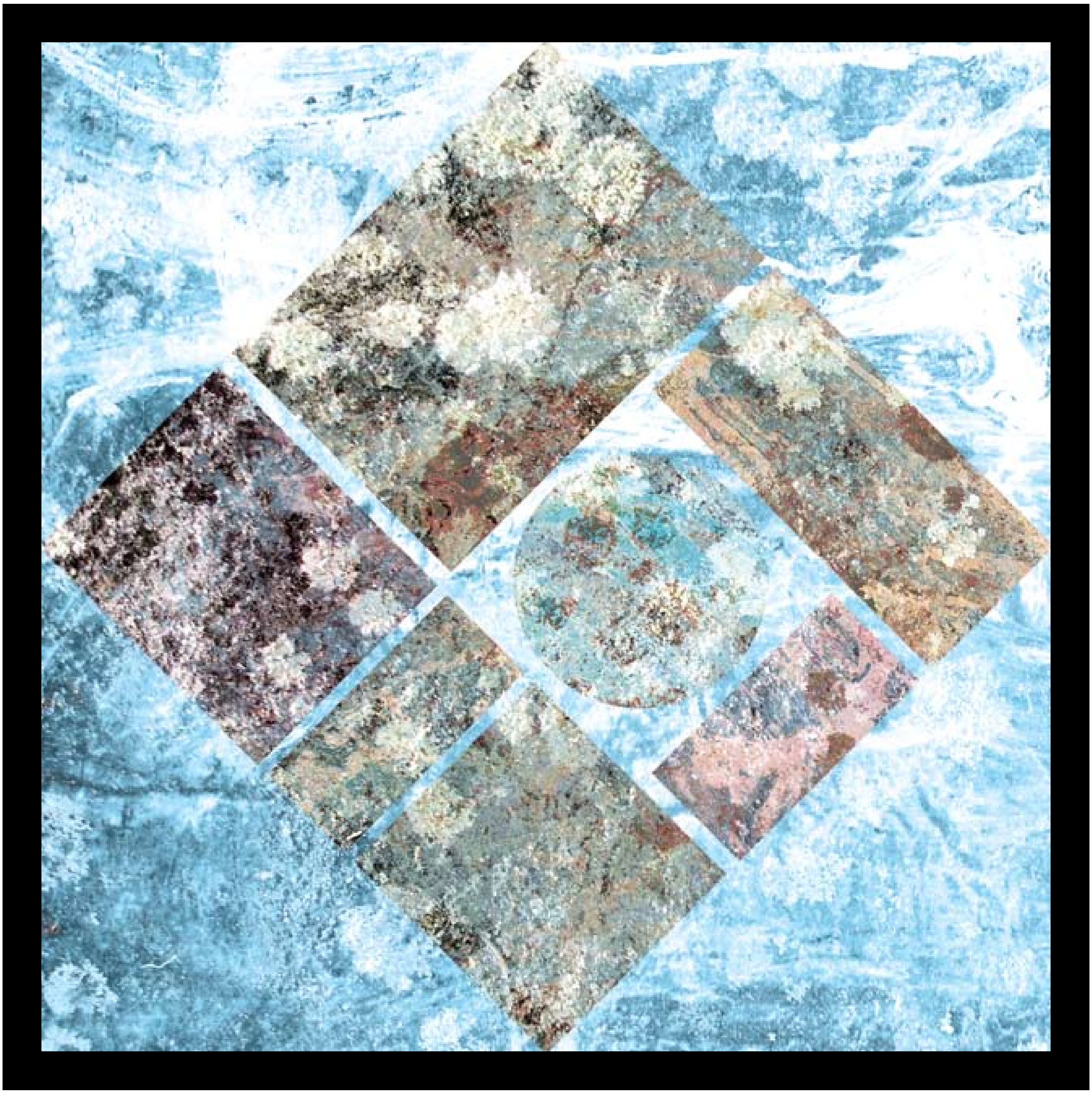
FOR HEALTH PROFESSIONALS

MS AUSTRALIA

PRACTICE

Balance for people with multiple sclerosis (MS)



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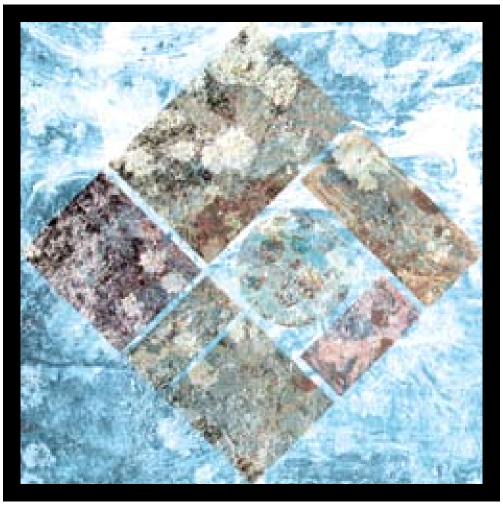

Balance for people with multiple sclerosis (MS)

People with MS can develop balance problems as a result of damage to the brain or spinal cord. Finding the best way to manage balance problems in people with MS requires a unique approach for each individual.

Contents

1.0 Balance

Balance is a product of the postural task undertaken and the environment in which it is performed. The characteristics of the task and the environmental context alter the biomechanical response strategies an individual selects to maintain balance, and the central information processing requirements and quantities.[1] An individual's biomechanical response strategies are dependent on the characteristics of the postural displacement, patient's expectations, goals, and prior experience. The amount of cognitive processing required for postural control depends both on the complexity of the postural task and on the capability of the patient's postural control systems.[2]

The requirements for balance and postural control are well described by Horak:[2]

- Postural orientation involves controlling the effect of gravitational force to maintain posture. Spatial orientation in postural control is based on the interpretation of convergent sensory information from somatosensory, vestibular and visual systems.
- Postural equilibrium involves the coordination of movement strategies to stabilise the centre of mass during both self-initiated and externally triggered disturbances to stability.

A number of physiological systems underpin a person's ability to balance. To manage balance dysfunction a therapist must understand and consider how the central nervous system (CNS) controls balance. The postural system consists of many components, and individuals will utilise various compensatory strategies to maintain function.[2] Loss of any of these control systems results in an increase in postural sway but may not impact on function because the level of control contributed by each system is still unknown.[3]

Information relating to balance has been obtained from studies involving populations of the healthy ageing, and those ageing with neurological conditions such as stroke and Parkinson's disease. Key findings are described below.

Balance — key evidence-based findings

- Many cognitive resources are required for postural control, with the more difficult postural tasks requiring more cognitive processing.[4]
- The capacity of central processing is not infinite when required to respond to complex balance demands. This is demonstrated by reduced functional performance when secondary tasks are undertaken within an ageing population,[5] and within a population with neurological conditions.[6]
- Sensory information from somatosensory, vestibular and visual systems is integrated, and relative weights are placed on each of these inputs. The weights allocated are dependent on the goals of the movement task and the environmental context. Healthy individuals in a well lit environment with a stable surface rely on information from somatosensory (70%), vestibular (20%) and vision (10%) to stay upright.[7] Individuals who are unable to re-weight their motor or sensory systems to an appropriate level (due to pathology) are at risk of falling.
- Any limitation imposed on the size and quality of the base-of-support will affect balance.[8] These limitations include strength of the lower limbs, pain in the feet or ankles, and altered sensation.
- The limits of stability (the area over which an individual can move their centre of mass and maintain equilibrium without changing their base-of-support) is internally represented in the CNS. Any disorders that affect this internal representation can lead to postural instability.[2]
- Movement strategies, such as ankle, hip, or stepping strategies, are associated with an increased risk of falls. An individual will utilise hip or stepping strategies when they are at risk of falling.[9]
- Poorly coordinated automatic postural responses lead an individual to greater instability during external perturbations. Poorly coordinated anticipatory postural adjustments lead an individual to greater instability during self-initiated movements.[10]
- Automatic and anticipatory postural adjustments use both proactive and reactive mechanisms to maintain upright posture.[1]
- A tilted or inaccurate representation of visual or postural verticality will result in automatic postural alignment that is not aligned with gravity, resulting in instability.[2]

2.0 Incidence and impact of balance impairment in MS

Approximately 75% of people with MS report problems with balance at some stage during the course of their disease.[11] Functionality is influenced to varying degrees by balance impairments, since balance requirements are dependent on functional tasks.[12–15] Furthermore, since MS can affect any area of the CNS, a number of systems may contribute to loss of balance control. The more systems damaged, resulting in balance dysfunction, the more difficult compensation will become.

The primary systems involved in the control of balance include:

- Motor system — activity, adaptation, and intention
- Somatosensory system
- Visual and vestibular system.

Further research on these systems is needed. Their influence on the afferent and efferent systems has not been investigated independently of each other, and a better understanding of their contribution to balance deficits may assist in guiding rehabilitation management.

3.0 Clinical characteristics of balance impairment

3.1 Motor system

Impairment of balance may be evident in a number of functional activities. For people with MS who have minimal disability on clinical examination (Expanded Disability Status Scale 0–4), a reduction in balance has been assessed or demonstrated in the following ways:

- Increase in the area of their self-selected base-of-support[16,17]
- Reduced functional reach with feet set at 10 cm[12,13,18]
- Reduction in gait speed, stride length, and increased double stance time[18–20]
- Reduction in ankle range and ankle muscle activation during walking, that is not consistent with those found in individuals unaffected by MS walking at comparable speeds[12,18,20]
- Reduction in gait velocity[17]
- A higher cadence at slow speeds among people with MS who have sensory defects, compared with people with MS who only have pyramidal and cerebellar symptoms[17]
- Demonstration of compensatory actions to maintain gait speed by increasing quadriceps torque in people with MS with sensory defects[21]
- Reduction in angular displacement of the trunk in seated reaching[14]
- A decrease in centre of pressure displacement (as measured by platform-posturography)[13]
- An increased sway in stance with feet together, eyes open and closed, with worsening sway as base-of-support decreases and with eyes closed (as measured by platform-posturography).[15,19,22]

Spatial gait parameters are commonly used as an indirect measure of walking stability. Reduced self-selected gait speed and increased double-stance time have been described as markers of instability in a number of studies of age-related gait changes.[23]

These changes are often adopted to ensure a more stable gait pattern to compensate for reduced balance control.[24] Similarly, people with MS whose balance control systems are affected, often adopt a slower self-selected gait speed, wider standing base of support, and increased double-stance time.

3.2 Somatosensory system

The term 'somatosensory' refers to sensory signals from all tissues of the body including skin, viscera, muscles, and joints, including light touch, vibration sense, temperature sense, and joint position sense. A few studies have demonstrated the influence of somatosensory loss on functions such as walking[21] or postural control in people with MS.[25,26] Thoumie *et al.*[21] observed that in the case of sensory loss there was a higher contribution of both flexors and extensors of the lower limbs to maintain gait speed.

Similarly, Rougier et al.[26] demonstrated that people with MS who are affected by proprioceptive loss need to develop augmented neuromuscular means (more energy expenditure) to maintain upright stance during quiet standing. No studies have specifically investigated the frequency or prevalence of somatosensory loss in people with MS. One study (not an epidemiological study) analysed clinical features of paraesthesiae in 127 patients with clinically definite MS. It was found that 40% mentioned paraesthesiae as a presenting symptom and 84% had persistent paraesthesiae by the time of this study.[27]

3.3 The vestibular system

Damage to the vestibular system due to MS can lead to vertigo, unstable gaze during head movement, gait ataxia, and imbalance.[10,28] The vestibular system signals the position of the head against gravity, and the changes in angular and linear velocity of the head. The vestibular nuclei in the brain stem receive convergent information from the vestibular, visual, and proprioceptive systems to control stability of the eyes, head, and trunk in space. An MS lesion may produce vertigo that mimics an acute peripheral vestibular defect (e.g., benign paroxysmal positioning vertigo). Vertigo in MS is multi-causational and has been reported to occur in approximately 20% of all people with MS. It has a prevalence of only 5% at any point in time.[26]

3.4 The visual system

The visual system – including the retina, optic nerve, chiasm, post-chiasmal pathways, the visual sensory cortices and their connections – may be damaged by the MS disease process.[26] A number of common ocular deficits experienced by people with MS include optic neuritis, visual field defects, and saccadic eye movement.

Optic neuritis is vision loss with or without pain. It is a symptom that is present in 20% of patients diagnosed with MS, and up to 50% of people with MS will develop optic neuritis over the course of their lifetime.[26] Peri-orbital or ocular pain may precede or accompany optic neuritis. The symptoms usually progress for two weeks with spontaneous resolution within four weeks.[29]

Visual field defects observed in people with MS as a result of optic neuritis may involve loss of vision in the central field, above or below the horizontal, or at the sides. After an episode of optic neuritis people with MS may or may not fully recover visual field loss. Saccadic eye movement is an extremely fast voluntary movement of the eyes, allowing them to accurately refix on an object in the visual field. This abnormal eye movement is often associated with lesions in oculomotor nerves or primary visual pathway.
Vision is particularly important when proprioceptive information in the regulation of lower limb position is decreased.[30] People with proprioceptive loss often compensate with their vision to prevent increased postural sway, loss of balance, and increased risk of falls. People with MS often rely on vision to compensate for lack of proprioceptive information on their body positioning.

Independent of any disease, process vision will decline, especially beyond the fourth decade. This decline affects contrast and glare sensitivity, adaptation and accommodation of the dark, as well as depth perception.[31] In the ageing population, increased risk of falls[32] and increased postural sway[33,34] have been correlated with a reduction in visual acuity, low contrast sensitivity, and depth perception. This increased risk is further compounded when a person wears bifocal lenses for vision correction and to assist with reading. For people with MS, the impact of potential residual symptoms from optic neuritis on balance and the risk of falls are compounded by the ageing process.

Damage to the vestibular system due to MS can lead to vertigo, unstable gaze during head movement, gait ataxia, and imbalance.[10,28]

4.0 Assessment of balance in MS

4.1 Motor system

Given the potential diversity of impairments that may occur in people with MS, it is recommended that a number of tools be employed to assess balance. Use of only one balance assessment tool may not elicit appropriate balance responses or be sensitive in measuring true balance owing to a person's ability to compensate or re-weight other systems to achieve the goal of balance.[30] For example, the use of functional reach is a valid and reliable measure for the identification of balance issues in people with MS.[12,15] However, it has been shown that people with MS may utilise alternative balance mechanisms when they achieve the same reaching distance as an age-matched healthy population.[13]

The test can also be compounded by strength or coordination issues within the arm, or may demonstrate ceiling or 'bottoming out' effects. Most balance assessment tools either assess balance with a stationary base of support or moving base of support. It is recommended at least one from each be used.[1] Other assessment tools used to investigate balance include the Berg balance scale, dynamic gait index, timed up-and-go test, and the Activities specific Balance Confidence (ABC) scale.[18,35,36]

Treating therapists will also need to employ individual assessments of the systems involved in balance control (e.g., vision, somatosensory, vestibular, and motor systems). For an accurate picture on the influence the different systems have on balance at the time of assessment, the use of sensory integration testing (with or without computer posturography), in combination with functional testing is advisable. To optimise early intervention and potential neuroplasticity, assessment is recommended soon after a diagnosis of MS. A recent study demonstrated the presence of balance impairment in newly diagnosed people with MS, without pyramidal symptoms.[18]

4.2 Somatosensory system

It is recommended that health professionals undertake systematic assessment of the various somatosensory systems using subjective and objective means. These include simple sensory testing of light touch and deep touch, passive movement and joint position sense, vibration sense and temperature sense. The use of the clinical test of sensory integration using computer posturography can assist in differentiating the systems involved.

4.3 Vestibular system

Clinically, the assessment and questioning of vestibular symptoms is warranted in order to determine central versus peripheral (benign paroxysmal positional vertigo) vestibular disorders. Peripheral vertigo presents with progressively fatigable nystagmus (rapid rhythmic and repetitious involuntary eye movements) and vertigo, occurring when a provocative manoeuvre is repeated three-to-four times, usually lasting a few seconds. Central vertigo symptoms and nystagmus maintain the same characteristics often lasting longer than 10 seconds and being provocative in many head or body movements.

Clinical tools that incorporate mobility and stimulate the vestibular system include the dynamic gait index,[35,37] and the timed 10-metre walk test (with and without head turns).[39] Dysfunction of the vestibular system may manifest itself in these tests as change of gait pattern, control or sensations of unsteadiness or vertigo.

Assessment of the vestibular dynamic visual acuity can be undertaken using the Snellen chart (with and without head movement). If people with MS have greater than a two-line difference for readings between their stationary and oscillating head movement, they are likely to have a vestibular defect.[37] Referral to a neuro-ontologist for formal testing is recommended.

4.4 Visual system

Testing for neuro-ophthalmic symptoms should be undertaken by an experienced neuro-ophthalmologist since many symptoms are only evident when using formal testing equipment. Physiotherapists can identify visual dysfunction during the subjective examination and by administering a self-reported questionnaire such as the National Eye Institute VFQ-25 questionnaire.[38,40]

A physiotherapist can undertake a neuro-optic assessment for range and quality of eye movement, noting nystagmus, range defects, reported symptoms, or vertigo and unsteadiness. Contrast letter acuity (contrast sensitivity) can be ascertained using Contrast Sloan Charts (otherwise known as the Pelli-Robson Sloan Letter Contrast Chart).[41–43]

Referral to a physiotherapist experienced in the assessment and management of vestibular issues may be an option to support the management of this group of people. The Australian Physiotherapy Association (APA) is a good resource for assistance in locating a physiotherapist with relevant experience.

5.0 Management of balance impairment in MS

5.1 Balance system

Few studies have examined the effect of training on a specific system impairment to improve balance. They have predominantly used a general rehabilitation approach incorporating balance exercises, variable surfaces, visual, proprioceptive or vestibular inputs, and incorporating functional or strength exercises.

Management strategies suggested in this publication are supported by evidence levels II–III. Only one known case series has demonstrated a positive change in balance using manipulation of the sensory input to improve balance output.[44]

Available evidence suggests that balance may be positively improved by:

- Individual physiotherapy using facilitation and functional activities[45,46]
- Group exercise classes, primarily by way of a functional based framework[47,48]
- Home balance training interventions[49]
- Targeted force-platform balance tasks.[50]

Intervention strategies that improved balance were conducted for a minimum of 45 minutes, once per week for a total of six weeks.

5.2 Vestibular system

Evidence supports the successful treatment of benign paroxysmal positional vertigo in patients with MS.[51,52] There is a paucity of evidence to support vestibular rehabilitation of central neurological deficits in people with MS.[26] Evidence in other neurological populations is emerging and generally shows positive outcomes.[53] Vestibular rehabilitation involves balance training using variable or moving surfaces, movement of the head (when the body is stationary or moving), decreasing visual inputs, as well as moving the head and/or eyes. Further research on the effectiveness of these rehabilitation strategies in people with MS is needed.

5.3 Visual system

There is no definitive approach to the management of visual symptoms in MS. In the acute stage most visual defects appear responsive to steroid therapy. There is literature supporting the management of saccades with baclofen or anti convulsants.[26] However, beneficial intervention of these symptoms by physiotherapists or other allied health professionals is not yet supported in the literature. At this stage, it is recommended that the presence of these symptoms and the impact they may have on visual information be noted. Providing education and advice about these symptoms is also recommended.

A neuro-ophthalmologist or behavioural optometrist may use prisms, patching, and modified glasses in their treatment regimen. The interpretation of the environment by the visual field will be affected when undertaking activity. People with MS will need to call on other systems to support balance and functional movement.

6.0 Identifying people at increased risk of falls

The prevalence of falls in people with MS has been reported to be 52%.[54,55] Many symptoms of MS are consistent with an increased risk of falls. People with MS have a high incidence of osteoporosis due to their use of steroids and lack of general activity,[56,57] therefore falls are more likely to result in injury.

Prevention of falls in people with MS may help avoid injury, hospitalisation, and increased care needs, which may otherwise be necessary. There is very little high-quality research identifying the risk factors for falls in people with MS. Further research is needed before risk factors can be addressed. Due to the variability of symptom prevalence and presentation, a physiotherapist should be involved in training all systems associated with balance during functional tasks.

Summary

- Balance impairment is a problem for approximately 75% of people with MS at some point during the course of their illness. Balance impairment has been found in the early stages of MS in the presence of minimal or no disability.
- As MS can affect multiple areas of the CNS, the impairment of several systems can contribute to loss of balance. These impairments include weakness, sensory loss, reduced visual acuity and vestibular disruption.
- Damage to the vestibular system in MS can lead to vertigo, unstable gaze during head turning, gait ataxia, and imbalance.
- People with MS often compensate for sensory and/or proprioceptive loss with their visual system. However, this compensation can be compromised in situations of low contrast and where there is a barrier to vision, such as when taking clothing over the head.
- People with MS have been found to have a slower self-selected walking speed and wider natural standing base of support than the general population
- There is evidence that balance may be improved by:
  - Individual facilitatory and functional style physiotherapy
  - Group exercise classes, primarily via a functional based framework
  - Targeted force-platform balance tasks.

References

1. Huxham FE, Goldie PA, Patla AE. Theoretical considerations in balance assessment. Aust J Physiother 2001; 47(2): 89–100.
2. Horak FB. Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? Age and ageing 2006 Sep; 35 (Suppl. 2): ii7–11.
3. Lord S, Menz H, Tiedemann A. A physiological profile approach to falls risk assessment and prevention. Phys Ther 2003 Mar; 83(3): 237–52.
4. Teasdale N, Bard C, LaRue J *et al*. On the cognitive penetrability of posture control. Exp Aging Res 1993; 19: 1–13.
5. Jamet M, Deviterne D, Gauchard GC *et al*. Age-related part taken by attentional cognitive processes in standing postural control in a dual-task context. Gait Posture 2007; 25(2): 179–84.
6. Yea-Ru Yang AB, Yu-Chung Chen C, Chun-Shou Lee B *et al*. Dual-task-related gait changes in individuals with stroke. Gait Posture 2007; 25(2): 185–90.

7. Peterka RJ. Sensorimotor integration in human postural control. J Neurophysiol 2002; 88(3): 1097–118.
8. Tinetti M, Speechlev M, Ginter S. Risk factors for falls among elderly persons living in the community. N Engl J Med 1988; 319: 1701–7.
9. Maki BE, Edmondstone MA, McIlroy WE. Age-related differences in laterally directed compensatory stepping behavior. J Gerontology 2000; 55(5): M270–7.
10. Horak FB. Adaptation of automatic postural responses. Acquisition of motor behaviours in vertebrates. Cambridge, MA: MIT Press. 1996. pp. 57–85.
11. Muller R. Studies on disseminated sclerosis with special reference to symptomatology, course and prognosis. Acta Med Scand 1949; 133(Suppl.): 122–4.
12. Frzovic D, Morris ME, Vowels L. Clinical tests of standing balance: performance of persons with multiple sclerosis. Arch Phys Med Rehabil 2000; 81(2): 215–21.
13. Karst G, Venema D, Roehrs T *et al*. Center of pressure measures during standing tasks in minimally impaired persons with multiple sclerosis. J Neurol Phys Ther 2005; 29(4): 170–80.
14. Lanzetta D, Cattaneo D, Pellegatta D *et al*. Trunk control in unstable sitting posture during functional activities in healthy subjects and patients with multiple sclerosis. Arch Phys Med Rehabil 2004; 85(2): 279–83.
15. Soyuer F, Mirza M, Erkorkmaz U. Balance performance in three forms of multiple sclerosis. Neurol Res 2006; 28(5): 555–62.
16. Bathersby MS. Resistance-exercise induced fatigue reduces performance on clinical tests of balance in women with multiple sclerosis. Gold Coast: Griffith University; 2007.
17. Thoumie P, Lamotte D, Cantalloube S *et al*. Motor determinants of gait in 100 ambulatory patients with multiple sclerosis. Mult Scler 2005; 11(4): 485–91.
18. Martin CL, Phillips BA, Kilpatrick TJ *et al*. Gait and balance impairment in early multiple sclerosis in the absence of clinical disability. Mult Scler 2006; 12(5): 620.
19. Ramdharry GM, Marsden JF, Day BL *et al*. De-stabilizing and training effects of foot orthoses in multiple sclerosis. Mult Scler 2006; 12(2): 219.
20. Benedetti MG, Piperno R, Simoncini L *et al*. Gait abnormalities in minimally impaired multiple sclerosis patients. Mult Scler 1999; 5(5): 363.
21. Thoumie P, Mevellec E. Relation between walking speed and muscle strength is affected by somatosensory loss in multiple sclerosis. J Neurol Neurosurg Psychiatry 2002; 73(3): 313–15.
22. Rougier P, Thoumie P, Cantalloube S *et al*. What compensatory motor strategies do patients with multiple sclerosis develop for balance control? Rev Neurol (Paris) 2007; 163(11): 1054–64.
23. Winter DA, Patla AE, Frank JS *et al*. Biomechanical walking pattern changes in the fit and healthy elderly. Phys Ther 1990; 70(6): 340–7.
24. Maki BE, McIlroy WE. The role of limb movements in maintaining upright stance: the “change-in-support” strategy. Phys Ther 1997; 77(5): 488–507.
25. Rougier P, Faucher M, Cantalloube S *et al*. How proprioceptive impairments affect quiet standing in patients with multiple sclerosis. Somatosens Mot Res 2007; 24(1–2): 41–51.
26. Frohman EM, Frohman TC, Zee DS *et al*. The neuro-ophthalmology of multiple sclerosis. Lancet neurol 2005; 4(2): 111–21.
27. Sanders EA, Arts RJ. Paraesthesiae in multiple sclerosis. J Neurol Sci 1986; 74(2–3): 297–305.26.
28. Herrera WG. Vestibular and other balance disorders in multiple sclerosis. Differential diagnosis of disequilibrium and topognostic localization. Neurol Clin 1990; 8(2): 407–20.
29. Agostoni E, Frigerio R, Protti A. Controversies in optic neuritis pain diagnosis. Neurol Sci 2005; 26 (Suppl. 2): s75–s78.

30. Horak FB, Esselman P, Anderson ME *et al*. The effects of movement velocity, mass displaced, and task certainty on associated postural adjustments made by normal and hemiplegic individuals. J Neurol Neurosurg Psychiatry 1984; 47(9): 1020–8.
31. Pitts DG. Visual acuity as a function of age. J Am Optom Assoc 1982; 53(2): 117–24.
32. Lord SR. Visual risk factors for falls in older people. Age and ageing 2006; 35 (Suppl. 2): ii42–5.
33. Turano K, Rubin GS, Herdman SJ *et al*. Visual stabilization of posture in the elderly: fallers vs. non fallers. Optom Vis Sci 1994; 71(12): 761–9.
34. Jacobs DA, Galetta SL. Multiple sclerosis and the visual system. Ophthalmology Clinics of North America. 2004; 17(3): 265–73.
35. McConvey J, Bennett S. Reliability of the Dynamic Gait Index in individuals with multiple sclerosis. Arch Phys Med Rehabil 2005; 86(1): 130–3.
36. Cattaneo D, Regola A, Meotti M. Validity of six balance disorders scales in persons with multiple sclerosis. Disabil Rehabil 2006; 28(12): 789–95.
37. Tusa R. History and clinical examination In. Vestibular Rehabilitation Third Edition Herdman, S Ed. 2007. pp. 108–24.
38. Noble J, Forooghian F, Sproule M *et al*. Utility of the National Eye Institute VFQ-25 questionnaire in a heterogeneous group of multiple sclerosis patients. Am J Ophthalmol 2006; 142(3): 464–8.
39. Herdman SJ. Vestibular Rehabilitation: Davis, F.A 2007.
40. Sui-Ling MA, Shea JA, Galetta S *et al*. Self-reported visual dysfunction in multiple sclerosis: new data from the VFQ-25 and development of an ms-specific vision questionnaire. Am J Ophthalmol 2002; 133: 686–692.
41. Baier ML, Cutter GR, Rudick RA *et al*. Low-contrast letter acuity testing captures visual dysfunction in patients with multiple sclerosis. Neurology 2005; 64(6): 992–5.
42. Balcer LJ, Baier ML, Kunkle AM *et al*. Self-reported visual dysfunction in multiple sclerosis: results from the 25-Item National Eye Institute Visual Function Questionnaire (VFQ-25). Mult Scler 2000; 6(6): 382–5.
43. Regan D, Raymond J, Ginsburg AP *et al*. Contrast sensitivity, visual acuity and the discrimination of Snellen letters in multiple sclerosis. Brain 1981; 104(2): 333–50.
44. Kasser SL, Rose DJ, Clark S. Balance training for adults with multiple sclerosis: multiple case studies. Neurology Report 1999; 23(1): 5–12.
45. Lord SE, Wade DT, Halligan PW. A comparison of two physiotherapy treatment approaches to improve walking in multiple sclerosis: a pilot randomized controlled study. Clin Rehabil 1998; 12(6): 477–86.
46. Wiles CM, Newcombe RG, Fuller KJ *et al*. Controlled randomised crossover trial of the effects of physiotherapy on mobility in chronic multiple sclerosis. J Neurol Neurosurg Psychiatry 2001; 70(2): 174–9.
47. Freeman J, Allison R. Group exercise classes in people with multiple sclerosis: a pilot study. Physiother Res Int. 2004; 9(2): 104–7.
48. Williams K, Hoang P. The benefits of exercising in groups versus at home independently for PwMS. International Multiple Sclerosis Conference. 2006; Sydney
49. Jackson K, Mulcare J, Donahoe-Fillmore B *et al*. Home balance training interventions for people with multiple sclerosis. Int J MS Care 2007; 9: 111–7.
50. Hatzitaki V, Koudouni A, Orologas A. Learning of a novel visuo-postural co-ordination task in adults with multiple sclerosis. J Rehabil Med 2006; 38(5): 295–301.
51. Frohman EM, Kramer PD, Dewey RB *et al*. Benign paroxysmal positioning vertigo in multiple sclerosis: diagnosis, pathophysiology and therapeutic techniques. Mult Scler 2003; 9(3): 250.
52. Pavan K, Marangoni BE, Schmidt KB, *et al*. [Vestibular rehabilitation in patients with relapsing-remitting multiple sclerosis]. Arquivos de neuro-psiquiatria. 2007; 65(2A): 332–5.
53. Brown KE, Whitney SL, Marchetti GF *et al*. Physical therapy for central vestibular dysfunction. Arch Phys Med Rehabil 2006; 87(1): 76–81.

54. Finlayson M, Peterson E, Cho C. Risk factors for falling among people aged 45 to 90 years with multiple sclerosis. Arch Phys Med Rehabil 2006; 87(9): 1274–9; quiz 87.
55. Cattaneo D, De Nuzzo C, Fascia T *et al*. Risks of falls in subjects with multiple sclerosis. Arch Phys Med Rehabil 2002; 83(6): 864–7.
56. Khachanova NV, Demina TL, Smirnov AV *et al*. [Risk factors of osteoporosis in women with multiple sclerosis]. Zhurnal nevrologii i psikhiatrii imeni SS 2006; 3: 56–63.
57. Ozgocmen S, Bulut S, Ilhan N *et al*. Vitamin D deficiency and reduced bone mineral density in multiple sclerosis: effect of ambulatory status and functional capacity. J Bone Miner Metab 2005; 23(4): 309–13.

MS Practice//For Health Professionals

MS Practice is an initiative of MS Australia (MSA). MS Practice is an online resource designed to support allied health professionals in the symptom management of people with multiple sclerosis (MS). The series addresses the various symptoms associated with MS, providing health professionals with evidence-based information and clinical practice recommendations to enhance the quality of care and outcomes for people with MS. The MS Practice topics were identified by the MSA Physiotherapy Network.

Balance for people with multiple sclerosis

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Credits

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MS Australia

MS Australia is a not-for-profit organisation that has been supporting people with MS since 1956. Through state-based MS Societies, MS Australia strives for a world without MS through quality research and service excellence for people with multiple sclerosis, their family and friends, and healthcare professionals.

MS Australia publications and information can be obtained from **www.msaustralia.org.au** or by calling the freecall number **1800 042 138**.

Disclaimer

This handout is intended to provide information to support current best practice for the management and treatment of physical impairments in people with MS. While the information is available to all health professionals, there are details that are most relevant to physiotherapists, exercise physiologists, and people who are qualified to provide exercise opportunities for people with MS. MS Australia has made every effort to ensure that the information in this publication is correct. MSA does not accept legal responsibility or liability for any errors or omissions, or for any physical or financial loss incurred whilst participating in the exercises or activities outlined in the MS Practice handouts. Be sure to seek advice from the sources listed.

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