Cervical Disk Pathology in Patients With Multiple Sclerosis: Two Case Reports

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Background and Purpose. A patient with multiple sclerosis (MS) may be seen by a physical therapist for evaluation before the MS diagnosis is definitively made, after a relapse, or during a progression. The diagnosis of MS should be part of the differential diagnosis if the symptoms of a patient with neurological issues fit the pattern of a progressive disease. Multiple sclerosis can affect any part of the central nervous system. Cervical pathology can be confused with relapsing symptoms of MS. The purpose of this case report is to demonstrate how easily cervical pathology can be overlooked in a patient with MS.

Case Description. Two case reports of patients with relapsing MS are presented. Both patients were referred for physical therapy after not responding to standard treatment with intravenous methylprednisolone. One patient reported multiple falls and complained of increasing cervical pain and spasm, fatigue, bouts of diplopia, and difficulty ambulating. The other patient complained of headaches, visual disturbances, and cervical pain with radicular symptoms. Contrast magnetic resonance imaging (MRI) did not reveal new MS lesions or the extension of old MS lesions. The cervical herniations in the first patient, not previously documented, were old. The bulging disks in the second patient, seen in a previous study, were unchanged. The MRI findings did not support the diagnosis of acute inflammatory MS or acute cervical pathology.

Outcomes. Both patients responded to physical therapy intervention once the cervical symptoms were directly addressed. As the cervical pain and spasm decreased, the relapsing MS symptoms of dysmetria, balance disturbance, and ataxic gait began to diminish. In both patients, eye function was slow to recover, with persistent impairment. Both patients returned to their premorbid activity and socialization level.

Discussion. Cervical disk disease should be considered in the differential diagnosis when a patient with MS has a history of trauma and displays abnormal postures, spastic weakness, and changes in pain complaints. In these 2 cases, treating the cervical pathology in addition to the MS symptoms provided the most effective approach for functional improvement.

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The patient with multiple sclerosis (MS) is frequently encountered in physical therapist practice. There are 25,000 newly diagnosed cases of MS in the United States.[1] There is strong evidence that MS is an autoimmune disease, although there is controversy as to whether the invasive elements that trigger the immune response are viral or bacterial.[2] This inflammatory response to an invasive agent is responsible for disrupting the blood-brain barrier and allowing the destruction of primarily white matter and, to a lesser degree, gray matter. Susceptibility to MS is considered multifactorial. Other factors that may disrupt the blood-brain barrier include trauma, environmental pollutants,[3] and vaccinations. Genetic disposition[4] can influence a person's vulnerability to MS. Lifestyle factors such as inactivity, stress,[5] and diet[6] can influence susceptibility to MS relapse and the course of the disease.

Multiple sclerosis is a poorly understood disease process that dismantles the myelin and myelin-producing cells, leaving lesions or plaques in the central nervous system (CNS). Gray matter destruction is associated with physical disability, fatigue, and cognitive impairment.[7] Prinster et al[8] were able to correlate regional loss of gray and white matter with indexes of clinical and radiological severity, Expanded Disability Status Scale scores, and lesion load in people with relapsing-remitting MS.

The McDonald diagnostic criteria are now being used to diagnose MS, but there is still a degree of ambiguity and confusion as to the definition of terms.[9] The diagnostic criteria define an exacerbation, time between attacks, requirement of magnetic resonance imaging (MRI) findings, cerebral spinal fluid and evoked potential abnormalities, criteria of follow-up MRIs, and progression characteristics.

Although late onset of symptoms and early presentation of optic neuritis are favorable predictors of outcome, multiplicity of symptoms and frequency of relapse suggest a poor outcome. Prediction of relapse using MRI loading, or factoring the number and location of lesions, is becoming more promising to diagnose exacerbations.[10]

Signs and symptoms of MS depend on the area of CNS involvement and can result in a plethora of symptoms. Patients with MS have sensorimotor and balance impairments, ataxia, tremor, seizures, cranial motor impairments, cognitive deficits, and behavioral disorders. Cervical myelopathic and radicular symptoms are seen in active MS involvement of the spinal cord. Magnetic resonance imaging with gadolinium contrast has been the conventional method to confirm new active lesions at the spinal cord or new spinal pathology, or as a process of elimination to differentiate them from mechanical derangement of old cervical pathology.

The physical therapist may encounter a patient with MS early in the disease process before a definitive diagnosis is made or after a relapse or progression. Although it is important for the physical therapist to be aware of MS as a differential diagnosis in the patient with neurological disease,[11] it also is important that there be a high level of suspicion for comorbid cervical disease or pathology that may confuse the clinical picture or response to treatment.[12]

It has been suggested that patients with MS having spastic weakness or postural deformities are more susceptible to spinal abnormalities and infections because of the abnormal compressive forces on the vertebra.[2] Both diseases are common, their coexistence is not unusual,[13] and multilevel disease can coexist in MS and confuse the diagnosis.[14] The most common symptoms found during a retrospective study of 14 people with definite MS who were scheduled for cervical decompression surgery were progressive myelopathy and radiculopathy.[15]

Important clinical considerations for cervical disease include the following: the age of the patient, a history of falls or trauma, repetitive activities, deconditioning, and comorbid diseases such as osteoporosis and diabetes that place the patient at risk.[16] Correctly identifying spinal abnormalities will determine effective strategies, physical therapy interventions, goals, and optimal outcome for rehabilitation.

Discussing the clinical radiological paradox, Dousset et al[17] noted that acute MS lesions most often can be detected on T2-weighted images based on the water content. Gadolinium crosses an open blood-brain barrier and reveals acute inflammatory lesions. Gadolinium studies are not foolproof in that chronic lesions can show up as acute lesions or new lesions may be completely missed; thus, adjunct MRI studies are being developed.[17] Most centers do not perform these expensive batteries of tests. Most of the MS trauma-related research has focused on injury as a cause of MS and not on investigating the effect of trauma on definitive cases of MS.[18]

Patient History and Review of Systems

This case report describes 2 patients who were referred for home health care with a diagnosis of relapsing MS. Both patients were referred for physical therapy by nursing staff after completing the standard treatment of IV methylprednisolone with only marginal resolution of their

Table 1.
Medications and Dosages for Patients 1 and 2[a]

Patient 1			
Medication	**Dosage**	**Medication**	**Dosage**
Advair Diskus (GlaxoSmithKline, Research Triangle Park, NC)	250 mcg	Crestor (AstraZeneca LP, Wilmington, DE)	10 mg po qd
INH	bid	D_3	6,000 mg po qd
Advil (Pfizer Inc, Kings Mountain, NC)	200 mg po qod	Lyrica (Pfizer Inc)	100 mg po qd
Betaseron (Bayer HealthCare Pharmaceuticals, Berlin, Germany)	0.3 mg subcutaneously qod	Nexium (AstraZeneca LP)	40 mg po qd
Carbamazepine	200 mg po bid	Nortriptyline hydrochloride	10 mg po qd
Citalopram	20 mg po qd	Singulair (Merck & Co Inc, West Point, PA)	10 mg po qd
Symbicort (AstraZeneca LP)	160 mcg INH bid	Tizanidine hydrochloride	2 mg po qd
Patient 2			
Medication	**Dosage**	**Medication**	**Dosage**
Advair Diskus	250 mcg INH bid	Crestor	10 mg po qd
Advil	200 mg po qod	D_3	6,000 mg po qd
Betaseron	0.3 mg subcutaneously qod	Lyrica	100 mg po qd
Carbamazepine	200 mg po bid	Nexium	40 mg po qd
Citalopram	20 mg po qd	Nortriptyline hydrochloride	10 mg po qd
Singulair	10 mg po qd	Symbicort	160 mcg INH bid
Tizanidine hydrochloride	2 mg po qd		

[a] INH=isoniazid, po=orally, qd=every day, qod=every other day, bid=twice a day, D_3=cholecalciferol.

symptoms. The patients demonstrated exacerbation of previous MS symptoms, particularly complaints of severe cervical pain, spasm, weakness of the upper extremities, and gait instability. No new MS lesions or extension of old lesions were noted in either case when gadolinium contrast MRI was done; however, old cervical pathology was noted at multiple levels.

The patient in the first case described her cervical pain as "different pain and spasms than I had before." The slow resolution of cervical symptoms after IV steroids prompted the physician to diagnose the patient with secondary progressive MS. An MRI was done to confirm suspected new lesions. The MRI did not support the diagnosis; however, it did confirm old cervical pathology that was previously unsuspected.

The patient in the second case complained of an exacerbation of previous MS symptoms, as well as new radicular pain in the left upper extremity. This patient previously had an abnormal MRI with known cervical bulging at 4 levels. The more recent MRI with contrast, however, showed no new MS lesions or change in cervical pathology.

Patient 1

The patient was a 41-year-old woman who was first diagnosed with fibromyalgia, but 10 years later was confirmed by McDonald criteria to have MS.[9] The patient was referred for home health care physical therapy with a diagnosis of relapsing MS. The patient was referred for physical therapy after IV steroid infusion, which slightly resolved her symptoms. The patient's past history was significant for seizure disorder, migraine headaches, visual loss, depressive disorder, hyperlipidemia, asthma, gastroparesis, a right ankle fracture 1 year previously requiring a bone graft, and multiple falls. Her past cortical and spinal MRIs had demonstrated MS plaques but no bony changes. During the physical therapist's evaluation, the patient complained of headaches, cervical pain and spasm that were "different," and diplopia. There was dysmetria, weakness and tremor of both arms, and increased impairment of balance and ataxia. The patient also complained of an increase in Uhthoff's phenomenon, or worsening of her MS symptoms with elevation of body temperature after exercise. Patient 1's medications and dosages are listed in Table 1.

Patient 2

The patient was a 45-year-old woman who also was referred for home health care physical therapy for relapsing MS 1 month after returning from a vacation trip to Panama. She also received IV steroid medication, with some resolution of her symptoms. She was first diagnosed with MS 5 years ago using the McDonald criteria. She initially was seen in the emergency department with symptoms of feeling detached and smelling foul, unusual odors. She was admitted to a psychiatric unit until experiencing optic neuritis, which prompted a thorough neurological examination and MRI. She was diagnosed with MS and a urinary tract infection.

The patient's past history was significant for migraine, vertigo, depressive disorder, and urinary tract infections. An MRI done 5 years ago showed demyelinating disease in 2 cortical areas and fluid surrounding the optic nerve. The cervical MRI showed a possible MS lesion in the cervical cord at the C5 level and in the T1-2 interspace. There also was mild posterior degenerative annular bulging at 4 cervical levels.

She had recently taken a vacation and rode a cable suspended over the rain forest holding on to a pulley slide. She was taking Provigil (Cephalon Inc, Frazer, Pennsylvania) medication to boost endurance and stated "I may have pushed too hard." She experienced worsening of MS symptoms, including cervical pain, within 24 hours after returning home. She also had swelling of the right jaw, which a dentist diagnosed as failure of a previous bone graft with infection.

She complained of patchy visual loss, headaches, severe cervical pain with radicular symptoms down the C5-6 distribution, sensory loss, increased tremor and dysmetria of both of her upper extremities, twitching of her thumb and index fingers bilaterally, and left arm weakness.

The most recent MRI showed confirmation of the old cervical spine plaque, with no active cortical lesions or changes in the bulging disks. Patient 2's medications and dosages are listed in Table 1.

Examination

The patients initially received a physical therapist evaluation that included assessment of the cardiovascular and pulmonary system, including vital signs; auscultation of the lungs; girth measurements; tests of gait, locomotion, and balance, including the Timed "Up & Go" Test (TUG),[19] the Tinetti Performance-Oriented Mobility Assessment (POMA),[20] and gait analysis; assessment of activities of daily living (ADL) and range of motion (ROM); manual muscle testing; reflex testing; the Modified Fatigue Impact Scale[21]; and special tests such as the Spurling test, Lhermitte sign, Babinski test, Hoffman test, distraction test, compression test,[22] cranial nerve testing, smooth eye pursuit, finger-to-nose testing, and clonus testing.

The physical therapist outlined short-term and long-term goals, including interventions. A prognosis to reach the stated goals also was included. The format of the home care progress notes included goals and interventions that were evaluated on each note. Significant findings are listed in Tables 2 and 3, and measurements are shown in Table 4.

Patient 1

The patient complained of severe cervical and bilateral arm pain that was "different than before" and rated the pain as 10/10, where a rating of 10 represents "worst pain imaginable." Cervical ROM was limited in all planes by 50%. Her sensation in the hands was diminished and did not appear to follow a dermatome. Her reflexes were +1 throughout both upper extremities. The lower extremities revealed clonus in both ankles, to a greater degree on the right. Tremor in the upper extremities was greater on the right and was more noticeable with fatigue. Strength of her right side was +3/5 compared with strength of 4/5 on the left side. Dysmetria appeared greater in her right upper extremity. Her dynamic sitting balance was 4/5, and her dynamic standing balance was +3/5. She required a roller walker to ambulate. She scored 10/28 on the POMA, indicating that she was at high risk for falls.[23] Her TUG score was 28. Her gait was ataxic and staggering. She required assistance for dressing, bathing, and all household activities.

Patient 2

The patient complained of cervical and radicular pain of 10/10 down the left upper extremity. During examination, radicular symptoms were immediately relieved after performing the distraction test. This is one of the positive tests for radiculopathy and indicated that manual traction could be effective.[20] There was numbness in her C5-6 distribution. Her cervical ROM was limited in all planes by 40%, except cervical rotation to the left, which was 50%. Muscle strength of her left arm was grossly +3/5. There were decreased reflexes of the left upper extremity. Reflexes in her right upper extremities and both lower extremities were within normal limits. Her dynamic sitting balance was 5/5, and her dynamic standing balance was 4/5. She refused to use an assistive device, although her POMA score was 18/28 and her TUG score was 18.

Clinical Impression

According to the *Guide to Physical Therapist Practice*,[24] the treatment

Table 2.
Differential Diagnosis: Symptoms in Multiple Sclerosis That Are Also Found in Disk Pathology[a]

Symptoms	Radiculopathy		Myelopathy	
	Patient 1	Patient 2	Patient 1	Patient 2
Decreased cervical ROM	x	L cervical rotation 40°	x	x
Postural deformity	x	x	x	x
Pain		LUE C5–6	Cervical	Cervical
Headaches		x	x	x
Muscle weakness		LUE	R side > L side	
Reflex changes		Decreased LUE	Decreased BUE, increased BLE	
Sensory changes		Decreased LUE	All 4 extremities	
Dysmetria			x	x
Dizziness			x	x
Positive Lhermitte sign			x	x
Positive Spurling test		x		
Positive distraction test	x	x		
Fasciculations	x	x		
Babinski sign			R x, L x	
Bladder/bowel incontinence			x	
Clonus			x	
Unsteady gait			x	x
Romberg sign			x	x

[a] ROM=range of motion, LUE=left upper extremity, BUE=bilateral upper extremities, BLE=bilateral lower extremities, R=right, L=left. "x" indicates presence of symptom.

of MS is within the scope of a physical therapist's practice. Multiple sclerosis is classified into pattern 5E: Impaired Motor Function and Sensory Integrity Associated With Progressive Disorders of the Central Nervous System. Cervical disk disease is classified into pattern 4F: Impaired Joint Mobility, Motor Function, Muscle Performance, Range of Motion, and Reflex Integrity Associated With Spinal Disorders.[24] This clinical pattern was obvious in patient 2, but not confirmed in patient 1 until after the contrast MRI.

Intervention

Both patients were treated for exacerbation of their MS symptoms in addition to their functional cervical disk pathology. Treatment time was 1 hour or longer, according to the patients' tolerance. Not all of the modalities could be used at once.

Cervical pathology was addressed using cryotherapy for pain and spasm for patient 1. Soft tissue mobilization, graded manual traction, ROM exercises, deep flexor stabilization, and proprioceptive neuromuscular facilitation (PNF) exercises were performed on her cervical regions. General strengthening exercises for her trunk and lower extremities and balance-based torso weighting techniques were used. Her ambulation progressed from a roller walker to a quad cane. A home exercise program was devised for her, and a cervical home traction unit was provided.

Cryotherapy, ultrasound, and soft tissue mobilization were utilized for pain and spasm for patient 2. Graded manual traction, ROM exercises, deep flexor exercises, and PNF exercises were directed to her cervical regions and upper extremities. A home program for general conditioning using her pool was added. She was shown how to use a cervical home traction device.

The interventions utilized with both patients are summarized in Table 5. Cryotherapy was effective for them. The patient in the first case was familiar with cooling body jackets that are designed for patients with MS. Both patients kept the environmental temperatures in their homes at 65° to 70°F. Soft tissue mobilization, graded manual traction, a home cervical traction unit, and balance-based torso-body weighting were utilized.

The patient in case 2 ambulated throughout the home while wearing a diving belt. The patient in case 1 was encouraged to start a walking

Table 3.
Symptoms of Multiple Sclerosis in Patients 1 and 2[a]

Symptoms	Patient 1	Patient 2
Fatigue > 6.5 on the Fatigue Severity Scale	x	x
Pain		
Migraine type headache	x	x
Trigeminal neuralgia	x	
Stabbing aching pain	x	x
Secondary pain due to muscle weakness, spasticity, or rigidity	x	
Eyes		
Diplopia (especially lateral gaze)	x	x
Partial vision, pain in one eye		x
Abnormal smooth eye pursuit	x	x
Uhthoff syndrome, heat sensitivity with visual symptoms	x	x
Sensorimotor system		
Incoordination/ataxia	LEs	
Decreased sensation	UE/LEs	LUE
Dysmetria	BUE	BUE
Tingling or burning	BUE	LUE
Hyperactive reflexes below the level of active lesion	BLE	
Clonus	BLE	
Tremor	BUE	BUE
Spasticity	BLE	
Muscle weakness	R side > L side	LUE
Lhermitte sign	x	x
Babinski sign	BLE	
Hoffman sign	No test	RUE
Romberg sign	x	x
Autonomic disturbances		
Sexual dysfunction		
Urinary incontinence	x	
Gastroparesis	x	
Bowel constipation		
Cortex		
Seizures	x	
Aphasia	x	
Speech hesitancy	x	
Emotional disturbances		Dx/bipolar
Depression	x	x
Dizziness/vertigo	x	
Dementia		

[a] LE=lower extremity, UE=upper extremity, LUE=left upper extremity, BUE=bilateral upper extremities, BLE=bilateral lower extremities, R=right, L=left, Dx=diagnosis. "x" indicates presence of symptom.

program, and pool exercises were shown to the patient in the second case. Physical therapy was scheduled twice a week for 6 weeks for both patients.

Outcomes

Patient 1

Upon treatment completion, the patient reported her pain at 4/10 daily, but not constantly. Diplopia occurred only with fatigue. Her cervical ROM was within normal limits except for left cervical rotation that was 10 degrees less than on the right side. Strength of her cervical muscles increased one grade within range. Weakness of her right side was one grade less than that of her left side and persisted. Her POMA score was 21/28. Her TUG score was 18. She continued to use the home cervical traction unit and followed through with the home exercise program.

Her level of independence improved, with the Outcome and Assessment Information Set (OASIS)-based ADL scores as follows: M1820=2/0, M1830=3/0, and M1860=2/1.[25]

She continued to complain of fatigue; however, her level of social participation improved so that she was able to enjoy dinners or family outings with proper pacing. An improved gait pattern allowed her to use a quad cane. There were no reported falls in the home. She was able to take public transportation and use air travel to visit her family.

Patient 2

The patient's cervical pain completely resolved. Cervical ROM had improved to within normal limits. There was resolution in her fasciculations bilaterally. Strength in the left upper extremity increased by half a grade in all muscle groups. Her POMA score was 21/28. Her TUG score was 15. Her ADL scores as defined in the OASIS had improved:

Table 4.
Clinical Findings in Patients 1 and 2[a]

Before Treatment		After Treatment	
Patient 1	**Patient 2**	**Patient 1**	**Patient 2**
Pain			
10/10 cervical and bilateral arm pain	10/10 left C5–6 radicular pain	4/10	Resolved
ROM			
Decreased 50% in all planes	Decreased 40% in all planes except external rotation 50%	WNL except left external rotation, which was 10% less than right external rotation	WNL
Tremor			
Both upper extremities, greater on right	None	Resolved	None
Strength			
RUE +3, LUE 4 RLE +3, LLE 4	LUE +3	Strength was improved 1 grade, but the right side persisted weaker than the left	LUE increased ½ grade
Tinetti Performance-Oriented Mobility Assessment			
10/28	18/28	21/28	21/28
TUG			
28	18	20	15

[a] ROM=range of motion, WNL=within normal limits, RUE=right lower extremity, LUE=left upper extremity, RLE=right lower extremity, LLE=left lower extremity, TUG=Timed "Up & Go" Test.

M1860=1/0, M1130=3/0, and M1880=1/0. Vision in her right eye was slow to detect light. She was beginning to see some light. More visual studies were planned for the future. She returned to her premorbid activity level and was able to accompany her son in college selection.

Discussion

Two patients with MS, who were taking disease-modifying drugs, were referred for home health care physical therapy with complaints of relapsing MS symptoms. A relapse is a clinical diagnosis characterized by signs of MS, which are either new or old and last for a few days or months. Both patients fit this description clinically; however, when MRIs with gadolinium contrast were done, no new lesions or extension of old lesions were seen in either patient.

Magnetic resonance imaging with gadolinium contrast has been considered the gold standard for determining new MS activity. A series of specific tests for MS have a sensitivity of 94% and a specificity of 55%.[26] Work has shown that gadolinium crosses the blood-brain barrier and detects active lesions in people with MS.[27] This activity persists for 4 weeks, on average, and at most 8 weeks. In both patients presented here, the gadolinium MRI was done within a 2- to 4-week period of symptoms. The MRI should have detected new lesions but did not. New inflammation was not perceptible on the MRI.

Corticosteroids can diminish or resolve active MS lesions on MRI, but the MS symptoms did not quickly resolve as expected with administration of IV steroids.

The gold standard MRI was done appropriately with gadolinium during the appropriate time period, after IV steroids that marginally resolved relapse symptoms.

A study by Merwick and Sweeney[28] showed that relapses may not be easily linked to a particular lesion on MRI, and can be pseudo-relapses. If there are no MRI changes, these relapses may be attributed to physiologic changes such as those due to infection, fever, medications, or electrolytes. The first patient was treated for an upper-respiratory infection, and the second patients was treated for a dental infection, but neither patient had improvement of her MS symptoms when treated with antibiotics. These 2 cases do not fit the definition of pseudo-relapse.

There is another concept that may explain the discrepancy between clinical presentation and MRI findings. This concept is called the "clinical-radiological paradox," which is described as a lack of clinical symptoms when the MRI is abnormal. These MS lesions are "silent" because neuroplastic processes may have occurred at the cor-

Table 5.
Evidence-Based Treatment[a]

Intervention	Rationale	Study
Cryotherapy, ultrasound, soft tissue mobilization	Acute onset pain and spasm reduction. Heat therapy is indicated in acute muscle pain and spasm, to a minimum due to heat insensitivity. Cryotherapy reduces inflammation, edema, and muscle spasm and decreases conduction velocity of nociceptors to block pain impulses.	Practice for health professionals: pain and multiple sclerosis. Available at: http://www.msaustralia.org.au/documents/ms-Practice/pain.pdf.
PNF to the cervical muscles	To improve proprioceptive joint sense of deep flexors, eye-head control, and relocation of head on the trunk.	Jull G, Falla D, Treleaven J, et al. Retraining cervical joint position sense: the effect of two exercise regimes. *J Orthop Res.* 2007;25:404–412.
Strengthening exercises	Patients with mild to moderate fatigue levels, if exercising at proper intensities, can improve strength without increasing or accelerating the disease process.	DeBolt LS, McCubbin JA. The effects of home-based resistance exercise on balance, power, and mobility in adults with multiple sclerosis. *Arch Phys Med Rehabil.* 2004;85:290–297. Dalgas U, Stenager E, Jakobsen J, et al. Resistance training improves muscle strength and functional capacity in multiple sclerosis. *Neurology.* 2009;73:1478–1484.
Balance-based torso-body weighting	Torso weighting is used to counteract directional balance loss in a patient with MS.	Gibson-Horn C. Balance-based torso weighting in a patient with ataxia and MS: a case report. *J Neurol Phys Ther.* 2008;32:139–146.
Specific cervical deep flexor exercises	Pain impairs deep flexor cervical muscles that stabilize the neck.	Jull GA, Falla D, Vincenzino B, Hodges PW. The effect of therapeutic exercise on activation of the deep muscle in people with chronic neck pain. *Man Ther.* 2009;14:696–701.
Cervical traction	Treatment of cervical radiculopathy using a multimodal technique. Cervical traction can be used for cases of herniated disks with mild compressive myelopathy.	Waltrop M. Diagnosis and treatment of cervical radiculopathy using a clinical prediction rule and multimodal intervention approach: a case series. *J Orthop Sports Phys Ther.* 2006;36:152–159. Browder DA, Erhard RE, Piva SR. Intermittent cervical traction and thoracic manipulation for management of mild compressive myelopathy attributed to cervical herniated disc: a case series. *J Orthop Sports Phys Ther.* 2004;43:701–712.
Aquatic therapy	Patients with MS can participate in aquatic therapy without increase in fatigue level or heat intolerance and improve their functional scores.	Petersen C. Exercise in 94°F water for a patient with multiple sclerosis. *Phys Ther.* 2001;81:1049–1058. Pariser G, Madras E, Weiss E. Outcomes of an aquatic exercise program including aerobic capacity, lactate threshold, and fatigue in two individuals with multiple sclerosis. *J Neurol Phys Ther.* 2006;30:82–90.
Aerobic exercise program	Aerobic training partially affected the health-related quality of life of patients with MS.	Rampello A, Franceschini M, Piepoli M, et al. Effect of aerobic training on walking capacity and maximal exercise tolerance in patients with multiple sclerosis: a random crossover controlled study. *Phys Ther.* 2007;87:545–555.

[a] PNF=proprioceptive neuromuscular facilitation, MS=multiple sclerosis.

tical and spinal cord levels, resulting in functional reorganization.[29]

There also can be clinical neurological deficits without MRI findings. After an inflammatory process, the destructive process that occurs to axons and myelin takes time to degenerate, phagocytize, and produce symptoms. For that reason, demyelination must be studied at the molecular level. Vascular adhesions and transmigration of mononuclear cells are key prerequisites in new lesion formation in people with MS. Magnetic resonance molecular imaging and nanotechnology have been proposed to increase the potential of MRI analysis.[30] Abnormalities can be missed in normal-appearing cervical cord tissue. There is a strong correlation between cervical cord area, a measure of atrophy, and clinical presentation. However, the frequency at which spinal cord MRI should be performed to track lesion load and atrophy has not been fully determined. Diffusion tensor imaging is being investigated as an adjunctive technique.[31]

One common denominator in both patients was trauma with previous cervical pathology. In the first case, the patient had one serious fall in the previous year but had multiple

minor falls just preceding the exacerbation of symptoms. The cervical herniations were not suspected and were undetected until the last MRI. In the second case, the cervical pathology was unchanged. Although trauma was less clear, patient 2 could have aggravated her preexisting cervical pathology during the recreational pulley ride over the forest, resulting in functional exacerbation of symptoms.

There are some other possible explanations for the exacerbation of the other MS symptoms without acute MRI findings. Multiple sclerosis is characterized by demyelination. Conduction velocity and amplitude of nerve transmission are suboptimal to begin with in patients with MS. Trauma may further weaken an impaired nervous system. The most reliable correlation between clinical status of the patient with MS and spinal cord lesions is cord atrophy.

A corresponding study offers an explanation for the appearance of diplopia, dysmetria, balance disturbance, and ataxia seen in patients with cervical pain. These symptoms are seen in people with MS and may be exacerbated by trauma and pain. A study by Krisjansson and Treleaven[32] looked at the effect of 2 physical therapy techniques—proprioceptive training and craniocervical flexion exercises—in the rehabilitation of patients with cervical pain. They suggested that pain afferents disrupt the proprioceptive afferents into the dorsal horn, resulting in abnormal position sense. Abnormal stresses on the vertebral joint may alter cervical afferent firing.[32]

In one case report, a patient with cervical cord injury and myelopathy had bilateral upper-extremity dysmetria and ataxic gait.[33] The symptoms subsided after surgical intervention. Hildingsson et al[34] studied 38 patients with eye motility dysfunction after soft tissue injury of the cervical spine, which they concluded was likely due to dysfunction of the proprioceptive system in the cervicocranial area.

Although these articles are not strong evidence, they do seem to support the importance of cervical function, vision, and balance. In the 2 cases presented in this case report, once the cervical dysfunction was treated, there was decrement of pain, improvement of head and eye coordination, and correction of cervical alignment. Treatment to the cervical region improved coordination of the upper extremities and steadiness of gait. There may be other factors that explain the improvement in gait and coordination, such as amelioration of deconditioning effects, improvement of cardiopulmonary status, and an improved sense of independence and well-being.

In summary, 2 patients with a diagnosis of relapsing MS were referred for home health care physical therapy. Both cases showed no new MS lesions on contrast MRIs. This finding could have been a limitation of the MRI technique; however, improved sensitivity and specificity of 94% and 55%, respectively, have been reported.[35] Corticosteroids could have diminished acute findings on the MRIs; however, many of the MS symptoms, although diminished, persisted for weeks afterwards. The steroids may have had an anti-inflammatory effect on some of the soft tissue structures and connective tissue, which may explain some of the initial improvement.

Both patients had chronic cervical disk pathology shown by MRI, which could account for a functional exacerbation of symptoms. Both patients had sustained trauma prior to the exacerbation of symptoms. Both patients had evidence of severe cervical spasm, scapular malalignment, and kyphoscoliosis because of the muscle imbalance. Derangement can place abnormal stresses on the nerve roots, as they exit the spine. Cervical pain and spasm can affect the proprioceptive input to the CNS, in turn, affecting coordination of the extremities and trunk.

When the appropriate physical therapy intervention was instituted, the cervical symptoms decreased and coordination and proprioception improved, with reduction in motor impairment and disability. Cervical disk disease should be considered in the differential diagnosis in a patient with MS if he or she complains of cervical symptoms.

The symptoms of cervical disk pathology can easily be confused with symptoms of relapsing MS. When the patient in the first case had suboptimal responses to IV steroids, the physician ordered a new MRI with contrast, suspecting secondary progressive MS requiring methotrexate, a more aggressive pharmacological treatment. When the MRI findings showed no new lesions, the physical therapy treatment was modified to treat the cervical pathology. The cervical radicular symptoms in the second case were more obvious, and the diagnosis of radiculopathy was made. Physical therapy treatment was directed to the cervical region early, based on clinical examination. The MRI results confirmed old cervical pathology and no new MS lesions shortly thereafter.

Patients with MS are referred for physical therapy with a diagnosis of relapsing MS. It is important that the clinician do a thorough review of the patient's medical history, establish a time line of progression, review pertinent diagnostic studies that are available, and perform a comprehensive systems review during the physical therapist evaluation. Patterns of

diagnoses are important to recognize, as well as which signs and test results may be clinically significant. Clinical improvement in response to cervical treatment potentially indicates that trauma may have been the catalyst to exacerbate previous cervical symptoms and weaken neurological areas that were already weakened in these 2 cases. The physical therapist must screen for spinal abnormalities when presented with a middle-aged patient with MS and a history of trauma showing abnormal postures or spastic weakness with complaints of changes in pain.

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