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Electromyographicanalysis of prevalence and characteristics of radiculopathy in Parkinson's disease

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Abstract

Background & Objectives: To determine the prevalence and characteristics of radiculopathy in Parkinson's disease (PD) patients through electrodiagnostic tests, to assess associated radicular pain characteristics,and to investigate the relationship between pain and other clinical manifestations of PD. *Methods:* Electrodiagnostic testing including nerve conduction studies and needle electromyographywas performed to investigate comorbid peripheral neuropathy or radiculopathy. All patients were asked to complete aquality of life (QOL) measurement related to pain. *Results:* Thirty-two (39%) of 82 PD patients had radiculopathy based on electrodiagnostic testing. 46.9% with radiculopathy patients had involvement of multiple roots level. The most commonly involved root was L5 (83.3%). Patients with radiculopathy had longer PD durations (p=0.011) and higher posture-related axial scores on the UPDRS scale (p=0.017).There was a trend for pain in the leg and low back to occur more frequently in PD patients with radiculopathy. QOL is not significantly different according to the presence of radiculopathy in PD.
Conclusions: This study demonstrates a high prevalence of radiculopathy, particularly multiple root involvement, and is correlated with pain complaints and with axial motor scores on UPDRS. These findings might be related to increased shear force at the intervertebral disc by axial rigidity and flexed posture in PD along with the duration and severity of PD disease course.

INTRODUCTION

Parkinson's disease (PD) patients frequently complain of painduringtheircourse of disease.[1-3] The overall prevalence of pain in PD is reported to range from 40% to 75%[2,4-6] and multiple etiologies have been identified in the development of pain.[7-12] Radiculopathy is a common and important cause of neuropathic pain in the elderly, particularly if radiculopathy develops in patients with PD, it could cause worsening of disability.[13,14,10,11] However, the nature of radiculopathy is not well characterized in patients with PD, because non-motor sensory symptoms of the disease are often masked by dominant motor symptoms. Mechanical stress at the intervertebral disc is a primarycontributing factor in the development of radiculopathy. Characteristic findings in patients with PD, such as truncal rigidity and abnormal flexed posture, may induce significant stress at the intervertebral discs, which may result in more prevalent radiculopathy in PD patients than general population.[15-19] Besides cardinal symptoms of PD, non-motor sensory symptoms also significantly impact quality of life[20], therefore it is important to correctly diagnose radiculopathy and understand associated pain characteristics in PD patients. The purpose of this study was to characterize and assess the prevalenceof radiculopathy in PD patients using electrodiagnostic studies, and to investigate the relationships of radiculopathy to pain and other cardinal motor signs of PD.

METHODS

Subjects

We enrolled PD patients, who consecutively visited a movement disorder clinic at a university affiliated hospital. PD was defined according to the clinical diagnostic criteria of the United Kingdom Parkinson's Disease Society Brain Bank.[16] Exclusion criteria were: 1) possible secondary causes for parkinsonism such as drugs or structural brain lesions, 2) history of radiculopathy before patients had symptoms or signs related to PD, 3) history of medical diseases such as cerebrovascular diseases, diabetes mellitus and arthritis, or prior surgery that might cause chronic pain, and 4) inability to complete

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questionnaires due to cognitive impairment (i.e. Mini Mental Status Examination < 24). 5) significant structural bony abnormalities, such as compression fractures, displacement of vertebral body etc. in simple spine x-ray. All patients were informed regarding the nature of the ongoing study and provided consent for voluntary participation. Ethical approval was obtained from the joint ethics committee of our institute.

Clinical assessment

Demographic features including age, gender, age at disease onset, and disease duration were obtained by either patient interview or review of medical records. A neurologist assessed patients during medication 'on' states to evaluate the Hoehn and Yahr (H&Y) stageof disease severity.[21] Part III scores in the Unified Parkinson's Disease Rating Scale (UPDRS)[22] were used to evaluate the degree of motor impairment including axial symptoms. PD patients were subclassified as a tremor-dominant (TD) type and postural instability-gait difficulty (PIGD) type according to the Jankovic's method.[23,24] Assessment of the UPDRS motor scores and questionnaire for the non-motor symptoms were performed during their medication "on" period.

Electrodiagnostic testing

Nerve conduction study (NCS) and EMG were performed to all participants. One side of the arm and leg with more prominent parkinsonian symptoms were sampled in the study. Electrodiagnostic testing was performed by an experienced electromyographer using a Viking IV EMG machine (Viasys, Nicolet Biomedical, Madison, WI, USA). Participants who were found to have peripheral neuropathies on NCS study were excluded from the study. A diagnosis of radiculopathy was made when EMG abnormalities were found in at least two muscles supplied by the same root but not by the same peripheral nerve. Additionally these abnormalities were not found in muscles supplied by normal roots adjacent to the affected root.[25] Samples of five muscles from the upper (biceps brachii, triceps, flexor carpi radialis, first dorsal interossei, cervical paraspinal) and five muscles from the lower extremity (quadriceps femoris, tibialis anterior, peroneus longus, gastrocnemius, lumbar paraspinal) were performed for screening. If abnormalities were found, more needle examination was then performed to confirm the diagnosis and to exclude other conditions. Interpretation of root involvement and myotomal distribution was performed according to the procedures of Wilbourn *et al*.[26]

Self-administered questionnaires

All patients were asked to complete questionnaires for quality of life (QOL) measurement regarding pain, depression and somatic anxiety. Patients were asked to describe the existence and location of pain during the past month. Depression was evaluated using the Zung depression inventory Self-Rating Depression Scale (SDS) that have 20 items with scores ranging from 20 to 80.[27] Somatic complaints were assessed using the Modified Somatic Perception Questionnaire (MSPQ) that consist of 13 items designed to measure heightened somatic awareness or somatic anxiety in patients with chronic pain.[28] The scores range from 0 to 39 with higher scores representing more somatic complaints. The Korean version of the Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) was performed to confirm the self-assessed quality of life related to health. SF-36 measures eight aspects of health status, including physical functions (PF), role limitations due to physical problems (RP), bodily pain (BP), general health (GH), vitality (VT), social functions (SF), role limitations due to emotional problems (RE), mental health (MH), and reported health transition. After analyzing the eight dimensions separately, the data was used to compute Physical Component Summary (PCS) and Mental Component Summary (MCS) scores using the equation provided by the Medical Outcomes Trust.[29]

Statistical methods

SPSS version 12.0 for Windows (SPSS Inc, Chicago, IL, USA) was used for all statistical analyses. The Mann-Whitney U test was performed to compare the demographic traits, clinical characteristics and questionnaire responses between patients with and without radiculopahy. Statistical results with p-values< 0.05 were considered significant.

RESULTS

Sample characteristics and demographic factors

Among 111 patients with PD who agreed to be enrolled in this study, twenty-nine patients were excluded due to diabetes mellitus (12 patients), arthritis (6 patients) and incomplete

electrodiagnostic study because of pain related to the study (11 patients). The final sample consisted of 82 patients with PD (54 women and 28 men, mean age=68.0±8.5 years, range=45-83 years). Thirty-two of the 82 patients (39%) were confirmed to have radiculopathy based on electrodiagnostic testing. No statistical differences related to age or gender distribution between patients with and without radiculopathy were found. Clinical features of both groups are presented in Table 1.

Comparison of clinical characteristics between patientswith and without radiculopathy

Patients with radiculopathy had significantly longer PD duration (4.2 ± 2.6 years) than those without radiculopathy (3.1 ± 2.8 years, p=0.011). The existence of radiculopathy was not correlated with either PD severity based on the H&Y stage during "on"-state (p=0.165) or the degree of motor impairment as assessed by the UPDRS part III sum score (p=0.853) at the time of examination. However, sub-score analysis of the UPDRS motor component revealed that PD patients with radiculopathy had more stooped posture (0.78) than those without radiculopathy (0.36, p=0.017). The other axial components including gait, ability to rise from a chair, and postural stability were not correlated with the presence of radiculopathy. The degree of depression, somatic anxiety and

Table 1: Demographic and clinical characteristics between patients with and without radiculopathy

	PD without radiculopathy (n=50)	**PD with radiculopathy (n=32)**	***p*-value**
Age (yr)	67.7± 9.0	68.3± 8.3	0.564
Sex (f:m)	24:26	14:18	0.482
Duration of disease* (years ± SD)	3.1 ± 2.8	4.2 ± 2.6	0.011
Hoehn&Yahr stage	1.97 ± 0.4	1.90 ± 0.7	0.165
1	4 (36.4)	7 (63.6)	
1.5	5 (55.6)	4 (44.4)	
2	32 (68.1)	15 (31.9)	
2.5	8 (66.7)	4 (33.3)	
3	1 (100)	0 (0)	
4	0 (0)	2 (100)	
UPDRS part III total score	11.7 ± 5.9	13.9 ± 11.3	0.853
Posture score on UPDRS part III (mean)*	0.36	0.78	0.017
MCS of SF-36	43.5 ± 15.6	42.7 ± 13.9	0.485
PCS of SF-36	41.2 ± 12.3	42.4 ± 8.0	0.246
SDS score	43.7 ± 10.3	44.4 ± 8.0	0.634
MSPQ score	23.7 ± 6.7	22.5 ± 5.3	0.383
Presence of pain on questionnaire (*N*, (%))	36 (72.0)	25 (78.1)	0.233
Site of pain (*N*, (%))			
Neck	3 (6.0)	2 (6.3)	0.999
Shoulder	11 (22.0)	3 (9.4)	0.138
Low back	26 (52.0)	18 (56.2)	0.078
Leg	7 (14.0)	10 (31.3)	0.060

* The mean difference is significant at the 0.05 level

PD = Parkinson's disease; UPDRS = Unified Parkinson's Disease Rating Scale (mean±SD);

H&Y stage = Hoehn & Yahr stage; MCS = Mental Component Summary (mean±SD); PCS = Physical Component Summary (mean±SD); SDS = Zung Depression Inventory-Self Depression Rating Scale (mean±SD); MSPQ = Modified Somatic Perception Questionnaire (mean±SD).

mental and physical component summary scores of SF-36 did not statistically differ between both groups (Table 1).

Distribution of pain

Pain distribution was similar to the distribution of the involved nerve roots. Of 82 patients, 61 (74.4%) patients complained of pain at various areas including low back (44 patients) and neck (5 patients). Pain distribution did not differ significantly between both groups, but there was a trend for pain in the leg and low back (the commonest type) to occur more frequently in patients with radiculopathy (Table 1). Twenty of 61 (32.8%) patients complained of pain in more than two body areas. The positive predictive value for the presence of pain in radiculopathy was 78% and the negative predictive value was 28%.

Characteristics of radiculopathy based on electrophysiologic study

Of the 32 PD patients with radiculopathy, 15 (46.9%) patients with radiculopathy had multiple root involvement (range of 2 to 5 roots). Lumbosacral region (56.3%) was most commonly affected, followed by mixed cervical-lumbosacral (28.1%) and cervical roots (15.6%). EMG testing showed abnormal findings primarily on L5 (81.3%) followed by L4, C8, C7, S1, C5, and C6 (Table 2).

DISCUSSION

In this electrodiagnostic study, 39% (32 of 82) of patients with PD had radiculopathy, and 46.9% (15 of 32) of the patients with radiculopathy had multi-level root involvement. The presence of radiculopathy in patient with PD is significantly correlated with disease duration and the degree of postural changes of PD. Various causes are involved in the pathophysiology of radiculopathy, including root compression, immunological, inflammatory and neurochemical origins.[30] Generally, the main cause of radiculopathies is root compression by disc herniation[31], while in patients over age 50, degenerative spondylosis is the most common cause of radiculopathy.[31-33] A previous study investigating loading of the spine by measurement of the intradiscal pressure according to the various activities reported that a round flexed back posture caused the highest intradiscal pressure which is one of key factors to develop disc herniation.[18] The characteristic stooped posture in patients with PD would be an accelerating factor for degenerative process in spine.[34,35] In addition, axial rigidity in patients with

Table 2: Overall characteristics of spinal roots involvement in 32 PD patients with radiculopathy based on electrodiagnostic testing

PD with radiculopathy on EMG (n (%))	32 (39.0)
Multiple roots involvement (n (%))	15 (46.9)
Location (descending order)	Number of involved roots (n (%))
L5	26 (81.3)
L4	10 (31.3)
C8	8 (25.0)
C7	6 (18.8)
S1	4 (12.5)
C5	2 (6.3)
Distribution of the involved roots	Number of patients (n (%))
Cervical roots only	5 (15.6%)
Lumbosacral roots only	18 (56.3%)
Cervical and lumbosacral roots	9 (28.1%)
Number of involved roots	Number of patients (n (%))
1	17 (53.1)
2	9 (28.1)
3	4 (12.5)
4	1 (3.1)
5	1 (3.1)

PD = Parkinson's Disease; EMG = Electromyography.

PD increase back muscle tone, may resulting in exacerbation of mechanical disc injury.[16,17,19] We also found that the prevalence of radiculopathy was correlated to disease duration of PD. When we consider that flexed posture occurs at relatively late stage in PD[15], the correlation of radiculopathy prevalence to disease duration support that postural change in PD could be one of causes to increase radiculopathy development in PD. Generally, the lumbosacral area is the most commonly involved area for radiculopathy.[26,36] In the present study, the prevalence of lumbosacral radiculopathy was 32.9% (27 of 82 patients). When we consider that the prevalence rate of lumbosacral radiculopathy in general population is approximately 3~5%, our study showed high prevalence rate.[31] The prevalence rate of cervical radiculopathies as17.1% (14 patients) in the present study is also higher compared to 5-10% in general adult populations.[18] In addition, 46% of patients with radiculopathy had multiple root involvement in the present study. These findings suggest that the disc burden in patients with PD issignificantly higher than that of healthy elderly. Musculoskeletal pain is the most common etiology of pain, but neuropathic radicular pain is also prevalent in PD[3] and these two types of pain would not be clearly classified in clinical practice. And this findings can elucidate the present findings of low sensitivity, relatively high specificity but high positive predictive value of pain in radiculopathy. We performed electrodiagnostic testing to confirm radiculopathy. There is no widely accepted diagnostic goldstandard for confirming radiculopathy.[37] Both magnetic resonance imaging (MRI).[38,39] and electrodiagnostic study, particularly needle electromyography (EMG)[26,40] are widely used diagnostic tools in clinical practice. However, because morphological abnormalities on MRI are frequently detected in even asymptomatic subjects, electrodiagnostic study, which could represent better physiologic status of root, is used in the present study.[41] However, it might have been more informative if we had performed both the electrophysiologic study and circumstantial imaging, though we excluded critical structural bony abnormalities through performing simple x-ray of the spine. In this study, we did not directly compare prevalence rate of radiculopathy with that in age-matched healthy controls. However, because of the associated pain with EMG study, it was very hard to perform needle examination to healthy controls. Another limitation of this study was we did not perform well-structured pain specific questionnaire to differentiate pain severity and nature. Lastly, it would be better when we further analyse pain of the PD with other motor variables, such as dyskinesia or motor fluctuations considering the data of Lim *et al*.[8] The rate of radiculopathy on electrophysiologic study reported in the present study is higher than that found in epidemiological studies of the general population[31], suggesting that radiculopathy is a significant condition in adults with PD. In summary, we found that radiculopathy, an important cause of chronic pain, is common in patients with PD. The presence of radiculopathy was significantly correlated with disease duration and postural changes of PD, supporting the degenerative nature of radiculopathy in PD. Early recognition of radiculopathy-related pain is important in clinical practice. Complaints of sensory symptoms should not be neglected, and radiculopathy should be considered a possible cause of pain in PD patients

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DISCLOSURE

Conflict of interest: None

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