Open Access Macedonian Journal of Medical Sciences. 2014 Dec 15; 2(4):626-631.
http://dx.doi.org/10.3889/oamjms.2014.112
Case Report

Gait and Computerized Dynamic Posturography (CDP) Aspects in Early Progressive Supranuclear Palsy (PSP) - A Case Report

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Citation: Mosalem DM, El Shabrawy AM, Alfeeli A, Baqer AB, Ahmed MM. Gait and Computerized Dynamic Posturography (CDP) Aspects in Early Progressive Supranuclear Palsy (PSP) - A Case Report. OA Maced J Med Sci. 2014 Dec 15; 2(4):626-631. http://dx.doi.org/10.3889/oamjms.2014.112

Key words: Computerized dynamic posturography (CDP); gait analysis; composite equilibrium score; Berge balance scale; progressive supranuclear palsy (PSP).

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Received: 22-Oct-2014; **Revised:** 05-Nov-2014; **Accepted:** 07-Nov-2014; **Online first:** 17-Nov-2014

Competing Interests: The authors have declared that no competing interests exist.

Abstract

BACKGROUND: Posture and gait instability may cause of morbidity in individuals with progressive supranuclear palsy (PSP).

OBJECTIVE: To quantitatively measure balance control by using computerized dynamic posturography (CDP) and to assess gait analysis in early PSP.

CASE REPORT: She was evaluated for Berge balance scale, Functional Independence Measure (FIM) and postural stability using CDP device in early PSP with still able to walk or stand unassisted. Also, Gait analysis was conducted using an 8 M-camera Vicon 612 data capturing system set. Berge balance scale improved from 41/56 to 48/56. The score of FIM improved from 71/126 points to 95/126 points in early PSP. In CDP analysis, there was a decrease of composite equilibrium score (38 %). There was an increase of composite equilibrium score (59%) after three months of treatment. In gait analysis, there was no difference of gait parameters after three months of treatment in early PSP.

CONCLUSIONS: Both CDP and gait analysis are important quantitative tools in the assessment of posture and gait instability as well as allow for early disclosure of the failure of the postural control system in early PSP.

Introduction

Progressive Supranuclear Palsy (PSP) is an uncommon neuro-degenerative condition, first described by Steele, Richardson, and Olszewski in1964 [1]. The main symptoms are postural instability with frequent falls and difficulty of moving the eyes in the vertical direction [2, 3].

Progressive Supranuclear Palsy (PSP) or Steele-Richardson-Olszewski syndrome is the most common form of atypical Parkinsonism (a parkinsonism-plus syndrome). PSP involves the progressive death of neurons in the brain, mainly in the basal ganglia, cerebellum and brainstem, just above the oculomotor nuclei, causing palsy and eventual paralysis of ocular movements (hence 'Supranuclear' being a key part of its name) [4-6].

The clinical picture of PSP is characterized by early postural instability with recurrent falls, vertical gaze palsy, pseudobulbar palsy with speech and swallowing problems, bradykinesia, axial rigidity, and subcortical dementia. The gait is clumsy, slow, and unsteady, resembling a "drunken sailor" [2, 3]. With the progression of the disease, walking is no longer independent, and after 5 years, on average, patients are unable to stand unassisted, requiring the use of a wheelchair [7].

Litvan I, et al [8] and Tolosa E, et at [9] reported that the dominant clinical problems of PSP case are severe postural instability with frequent falls and vertical gaze palsy. The falls usually happen unexpectedly and very often are in a backward

direction. Falls are associated with a poor quality of life and are a major cause of morbidity in individuals with PSP.

Santacruz et al found that the early presence of falls, bradykinesia, and inability to move the eyes downward are negative factors in the survival time of patients. The assessment of functional levels and staging of the symptoms in PSP may be particularly helpful to predict the prognosis of the disease [10].

Mobility problems are the commonest early feature in PSP and visual symptoms are often functionally disabling. Early falls, speech difficulty, swallowing problems and diplopia predict reduced survival [11]. Nath et al confirmed the relationship between survival time and the onset of early falls, and they also reported bulbar problems and diplopia as negative predictors [11].

Methods

She was evaluated for Berge balance scale, Functional Independence Measure (FIM) and postural stability using computerized dynamic posturography (CDP) device. Also, Gait analysis was conducted using an 8 M-camera Vicon 612 data capturing system set.

Diagnosis of PSP patient depends upon several clinical features according to the National Institute of Neurological Disorders and Stroke/ Society for PSP (NINDS/SPSP) criteria [10] including vertical gaze palsy, recurrent falls in a backward direction, bulbar signs (difficulty with speech and swallowing) and failure to respond to anti-parkinsonian medications such as levodopa [2, 3].

Moreover, she was diagnosed as the early stages of PSP with still able to walk or stand unassisted according to Goetz CG et al for classification of gait impairment [7] and Modified Hoehn and Yahr Staging scale [12]. Goetz CG et al classified gait impairment and as the prognosis of PSP into 3 different levels: loss of independent walking, inability to stand unassisted, or requiring a wheelchair. Their main finding was that 48% of the patients reached 1 of the 3 levels of impairment within 4 years of onset of the disease [7].

The Hoehn and Yahr staging scale is a commonly used system for describing how the symptoms of Parkinson's disease progress and is useful in assessing PSP. It included stages 1 through 5. Since then, a modified Hoehn and Yahr scale was proposed with the addition of stages 1.5 and 2.5 to help describe the intermediate course of the disease. Modified Hoehn and Yahr Staging scale includes stage 0 = no signs of disease, stage 1 = unilateral disease, stage 1.5 = unilateral plus axial involvement, stage 2 = bilateral disease, without impairment of balance, stage 2.5 = mild bilateral disease, with recovery on pull test, stage 3 = mild to moderate bilateral disease; some postural instability; physically independent, stage 4 = severe disability; still able to walk or stand unassisted and stage 5 = wheelchair bound or bedridden unless aided [12].

The Functional Independence Measure (FIM) is instrument that aim to describe activities of daily living (ADL) and levels of dependency/ independency. The FIM can be considered “golden standards” for ADL assessment [13]. It is designed 18 items including 13 physical items and 5 cognitive/social items. Each item is rated on a seven-point scale, from total assistance to complete independence. Total scores range from18 to 126, with 126 indicating complete independence [13].

The Berg Balance Scale (BBS) also was used to assess balance. Thirty-eight component balance tests were originally selected and then refined to 14 items, each scored from 0 to 4, making a possible total score between 0 and 56, with a higher score indicating better balance [14]. Berg Balance scale of patient can detect independent walking with low risk falling with a high score [14].

Assessment and training for postural stability in the early PSP was done by using computerized dynamic posturography (CDP) device. The SMART Balance Master was used for the postural stability assessment. The sensory organization test (SOT) is a component of computerized dynamic posturography device which included six test conditions which lasting 20 seconds each, and repeated three times to get stable values. The first three conditions include SOT 1 (eyes open), SOT 2 (eyes closed), SOT 3 (sway-referenced vision with standing on a fixed platform called static posturography. The second three conditions include SOT 4 (eyes open), SOT 5 (eyes closed), SOT 6 (sway-referenced vision with standing on a moving platform called dynamic posturography. Composite equilibrium score (CES%) was calculated that describes the overall level of performance under the six conditions. Scores range from 0 to 100, with 0 representing a fall and 100 representing perfect stability [15].

Gait analysis (a video motion analysis system) was conducted using an 8 M-camera Vicon 612 data capturing system set at 120 Hz and 3 force plates mounted midway on an 8-m walkway. Retro-reflective markers were placed on the specific anatomic points of the subjects’ lower limbs, enabling 3-dimensional analysis during the gait cycle. These points were the anterior superior iliac spines, sacrum, mid thighs, lateral malleoli, dorsolateral aspect of the foot between the second and third metatarsal heads, and on the calcaneus. Workstation and Polygon software were used to manually define gait cycle events and to process kinematic and kinetic data [16].

Case Presentation

Our patient is 56 years old Kuwaiti female, house wife who presented with slowness of movement, difficult of speech, frequency of falls, disturbance of memory and urinary incontinence in August 2009. This history started with insidious onset by frequency of falls and unexplained urinary incontinence 5 years ago, then; progress to memory problems , speech deterioration 2 years ago followed by chocking attacks to fluids one year ago. Her daughter noticed personality changes as depressive effects, she became house-bound. Not demanded or anxious. MRI showed mild midbrain atrophy and EMG was normal. She had comorbidity disorders including Hashimots thyroiditis, glaucoma, hyperlipidemia, OA knees and Lumber spondylitis. Patient received Sinemet 10\100, tds and Coenzyme Q10 200 mg q.i.d with mild improvement.

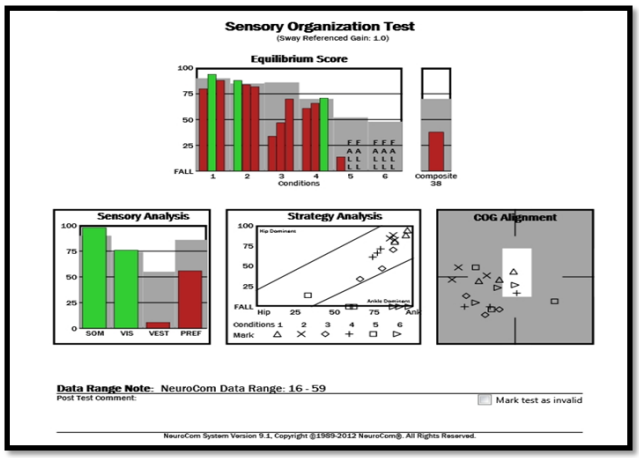


Figure 1: Sensory organization test with Composite Equilibrium Score (CES 38%) before treatment in the early PSP.

On examination, patient was conscious, oriented, and cooperative with starring appearance, vertical gaze paresis, poor convergence, tonic contraction of forehead muscles. There was dysarthria with slurred speech and dysphonia as well as dysphagia with chocking to fluid. She had good voluntary control of all muscles of four limbs 4/5, no tremors, slightly increased tone with no cogwheel rigidity, briskly DTJ, Bilateral +ve Babinski, preserved sensation, no signs of incoordination, -ve Romberg sign and incontinence of urination. Our patient also seen in our phoniatric clinic, video laryngoscope revealed incomplete closure of vocal cords bilateral& wasting.

She was diagnosed as the early stages of Progressive Supranuclear Palsy (PSP) with still able to walk or stand unassisted according to Goetz CG et al for classification of gait impairment (7) and Modified Hoehn and Yahr Staging scale [12].

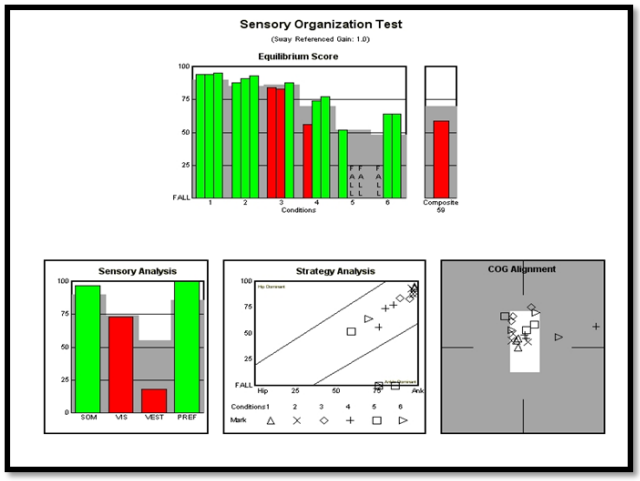
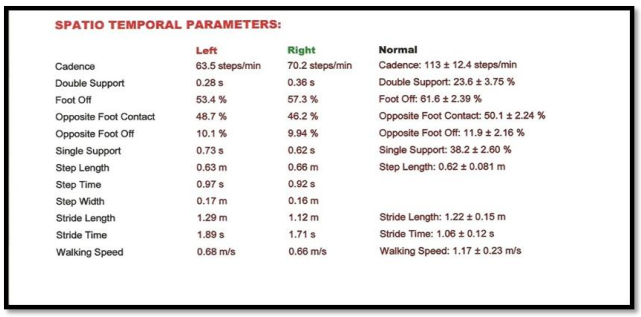


Figure 2: Sensory organization test with Composite Equilibrium Score (CES 59%) after treatment in the early PSP.

In October, 2009, Berg Balance scale was 41\56 which means that patient can be independent walking with low risk falling. She was assessed in balance clinic, sensory organization test revealed that there was poor composite equilibrium score about 38%, fair-good static standing balance, poor dynamic standing balance with COG deviates mildly to left & back ward position (Figure 1).

The gait of our patient analyzed in our gait lab for Gait cycle parameters showed slow walking speed (m/s) about 0.4/1.7 m/s (normal value about 1.7 m), slow cadence (number of steps/per minute) about 63.5 steps/per minute (normal value about 113 steps/per minute) and foot off with more foot contact ground in PSP gait (Figure 3). Also, Kinetics and Kinematics studies revealed that low power of muscles of joints in Kinetic study and less angles of joints of ankles, knees, hips in Kinematics study, figures [4-5].



SPATIO TEMPORAL PARAMETERS:

	Left	Right	Normal
Cadence	63.5 steps/min	70.2 steps/min	Cadence: 113 ± 12.4 steps/min
Double Support	0.28 s	0.36 s	Double Support: 23.6 ± 3.75 %
Foot Off	53.4 %	57.3 %	Foot Off: 61.6 ± 2.39 %
Opposite Foot Contact	48.7 %	46.2 %	Opposite Foot Contact: 50.1 ± 2.24 %
Opposite Foot Off	10.1 %	9.94 %	Opposite Foot Off: 11.9 ± 2.16 %
Single Support	0.73 s	0.62 s	Single Support: 38.2 ± 2.60 %
Step Length	0.63 m	0.66 m	Step Length: 0.62 ± 0.081 m
Step Time	0.97 s	0.92 s	
Step Width	0.17 m	0.16 m	
Stride Length	1.29 m	1.12 m	Stride Length: 1.22 ± 0.15 m
Stride Time	1.89 s	1.71 s	Stride Time: 1.06 ± 0.12 s
Walking Speed	0.68 m/s	0.66 m/s	Walking Speed: 1.17 ± 0.23 m/s

Figure 3: Spatiotemporal gait parameters in with slow walking speed, slow cadence and foot off with more foot contact ground in early PSP.

Functionally, she had good sitting balance, stand with mild assistance, fair static standing balance, and poor dynamic balance, bradykinesia and stiff gait with walking with walker and assistance in ADL. The score of Functional Independence Measure (FIM) was 71 points out of 126 points

Rehabilitation plans include physical therapy, occupational therapy, balance evaluation and training, cognitive rehabilitation as well as speech and swallowing therapy. She received complex training course for three months including visual feedback balance training (twice weekly) by using computerized dynamic posturography and conventional physical therapy (three times weekly). In balance exercises with the conventional therapy, she received verbal and tactile cues to encourage symmetrical stance and weight shifting. She was evaluated by the study of postural stability by computerized dynamic posturography device before and three months after the training program.

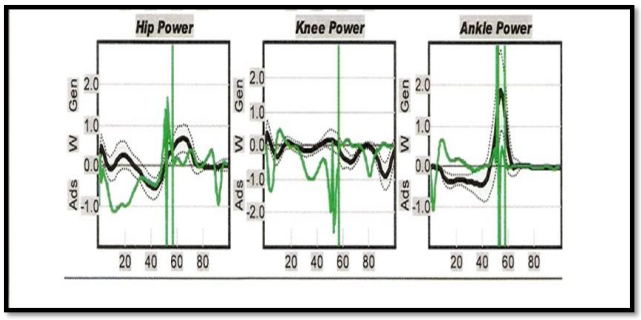


Figure 4: Kinematics study: Average curves for SPS patient (less dark line) and control subject (dark line) with fewer angles of joints of ankles, knees, hips (Goniogram of joint motions).

After 3 months of rehabilitation, she showed less frequency of falls and some improvement in balance with good static standing and dynamic standing balance with ability to walk independtly under supervision. Berge balance scale improved from 41/56 to 48/56. The score of Functional Independence Measure (FIM) improved from 71 points to 95 points out of 126 points. However, there was no difference of gait parameters after three months of treatment. Sensory organization test showed that equilibrium score improved from 38% to 59% (Figure 2).

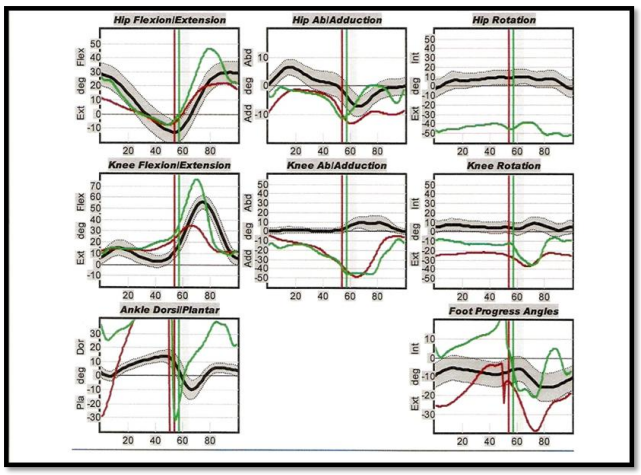


Figure 5: Kinetic study: Average curves for SPS patient (less dark line) and control subject (dark line) with low power of muscles of joints.

Discussion

In the present study, our patient with early PSP is characterized by early postural instability with poor equilibrium score about 38% and gait instability. In agreement with our results, some authors reported that PSP is characterized by early postural instability with recurrent falls, vertical gaze palsy, pseudobulbar palsy with speech and swallowing problems, bradykinesia, axial rigidity, and subcortical dementia. The gait is clumsy, slow, and unsteady, resembling a "drunken sailor" [2, 3].

Moreover, Litvan I, et al., [8] and Tolosa E, et al., [9] reported that the dominant clinical problems of PSP case are severe postural instability with frequent falls and vertical gaze palsy. The falls usually happen unexpectedly and very often are in a backward direction. Falls are associated with a poor quality of life and are a major cause of morbidity in individuals with PSP. Santacruz et al found that the early presence of falls, bradykinesia, and inability to move the eyes downward are negative factors in the survival time of patients [10]. Mobility problems are the commonest early feature in PSP and visual symptoms are often functionally disabling. Early falls, speech and swallowing problems and diplopia predict reduced survival [11].

In the present study, we investigated the benefits of balance training for improving posture instability and gait in early PSP. Sensory organization test showed that composite equilibrium score improved from 38% to 59% Berge balance scale improved from 41/56 to 48/56. The score of Functional Independence Measure (FIM) improved from 71 points to 95 points out of 126 points in early PSP. However, there was no difference of gait parameters after three months of treatment in early PSP.

In agreement with our results, Izzo et al., depended upon rehabilitation program included limb-coordination activities, tilt-board balancing, ambulation activities incorporating trunk flexion and rotation, and strategies to compensate for impaired visual scanning. At the end of the exercise program, improvements were observed in the patient's standing balance and ability to scan the environment. Fine coordination remained the same, and gait characteristics showed little improvement, although the patient reported feeling safer during ambulation. Functionally, the patient was described as having moderate involvement in motor function [17].

A similar report by Sosner et al., described the rehabilitation of 2 patients. Both patients showed moderate involvement in motor function. Each patient followed an individualized rehabilitation program that involved strength training with progressive resistive exercises and isokinetic exercises, coordination exercises, gait training, and transfer training to and from a bed and chair, and stretching of the neck

muscles. In addition, the second patient was taught to compensate for downward gaze impairments by using head movements [18].

In 2002, Suteerawattananon et al., [19] reported a case report using a body-weight–support training program for a patient with PSP. The patient had mild to moderate motor involvement. Also, the results of the case study showed improvement on all measures except the Timed "Up & Go" Test. According to the authors, the lack of improvement on the Timed "Up & Go" Test can be justified by the fact that the patient was not trained in sequencing of motor tasks or sit-to-stand activities [19].

In disagreement with our results, no observations were made related to changes in balance, coordination, strength, or transferring abilities after the exercise program [17]. Moreover, in contrast to our results, Zampieri C found that significant improvements in stance time and walking speed for the treatment group, whereas the comparison group showed improvements in step length only [20].

Mechanism of posture instability and gait disorders in PSP probably occurs as a result neurodegenerative changes in PSP and progressive deterioration in motor and subcortical cognitive function [1]. Also, neuropathological alterations involved neuronal loss and neurofibrillary tangles in the basal ganglia, brain stem, and cerebellum in SPS. There is the progressive degeneration of the brain structures localized superior to the oculomotor nuclei, causing palsy and eventual paralysis of ocular movements [1].

Moreover, the neuropathologic features of PSP include marked midbrain atrophy and atrophy of the pallidum, thalamus, subthalamic nucleus and frontal lobes [21]. There are features of PSP that are likely to contribute to gait abnormalities. Motor causes include weakness and spasticity, which along with bradykinesia is thought to explain the ‘lurching’ style gait [3]. Also, many of the cognitive problems that are features of PSP may contribute to gait instability, including apathy and decline of executive function, reduced processing speed, impaired attention, and diminished working memory [22]. Ondo et al., [23] showed that people with PSP had markedly worse postural control compared with people with PD matched for age and disease duration. A patient with PSP will likely have some level of vertical oculomotor palsy, which contributes to poor postural control [24].

Explanation of some improvement in posture stability may be due to the early stages of PSP and good response to complex training course for six months including visual feedback balance training and conventional physical therapy.

In a conclusion, falls are associated with a poor quality of life and are a major cause of morbidity in individuals with PSP. PSP pathology affects both posture and gait control pathways. Both computerized dynamic posturography and gait analysis are important quantitative tools in the assessment of posture instability and gait as well as allow for early disclosure of the failure of the postural control system in early PSP. Visual feedback-based balance training was shown to be a promising method for fall prevention among individuals with SPS.

Acknowledgments

We acknowledge to our colleagues in Physical Medicine and Rehabilitation Hospital, Kuwait for their assistance.

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