Journal of Novel Physiotherapies

Okada et al., J Nov Physiother 2014, 4:5
http://dx.doi.org/10.4172/2165-7025.1000233

Mini Review Open Access

Rehabilitation for Postural Deformities in Parkinson's Disease: An Update and Novel Findings

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Received date: November 10, 2014; **Accepted date:** November 18, 2014; **Published date:** November 24, 2014

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Abstract

Rehabilitation is one of important treatments for postural deformities in patients with Parkinson's disease. Various possible mechanisms have been suggested. Among these, soft tissue changes such as reduced flexibility and muscle weakness and proprioceptive disintegration that likely induce impaired vertical perception seem to be partially improved by rehabilitation. For soft tissue changes, stretching, strengthening and functional exercise are adopted. For proprioceptive disintegration, postural reeducation exercises are adopted to promote proper postural realignment in each plane. This short review provides an update on the rehabilitation for patients with Parkinson's disease with anterior bending posture and lateral bending posture, and introduces novel rehabilitation interventions and assessment methods for postural deformities.

Keywords: Parkinson's disease; Postural deformities; Rehabilitation; Soft tissue change; Postural reeducation; Galvanic vestibular stimulation; Kinect

Introduction

Postural deformities are disabling complications in patients with Parkinson's disease (PD). Severe postural deformities in PD patients include camptocormia (severe (minimum 45 degrees) anterior bending posture, but relived in the spine), pisa syndrome (severe (minimum 10 degrees) lateral bending posture, but almost alleviated in the spine), scoliosis (lateral bending not relieved passive movement), and antecollis (severe (minimum 45 degrees) anterior neck flexion) [1].

Rehabilitation is one of important treatments for postural deformities in PD patients. However, there has been very small number of reports on effectiveness of rehabilitation for mild to moderate anterior and/or lateral bending posture, pisa syndrome and camptocormia and no reports on that for scoliosis and antecollis, as far as we know. In this short review, we briefly summarize postural rehabilitation in PD patients with lateral bending posture (including pisa syndrome) and those with anterior bending posture (including camptocormia) and provide information about the possibility of novel interventions for postural deformities in PD patients.

Rehabilitation for Postural Deformities

Various treatments, such as antiparkinson drugs [2-4], deep brain stimulation [5-9], lidocaine injection [10,11], botulinum toxin injection [12-15], spinal magnetic stimulation [16], orthosis and physiotherapy [16] were administered to improve postural deformities, but there is insufficient evidence concerning the effectiveness of these treatments. Possible mechanisms involved in postural deformities in PD patients are dystonia, rigidity, drugs, myopathy, degenerative spinal changes, soft tissue changes, and proprioceptive disintegration [1]. Among these, soft tissue changes and proprioceptive disintegration seem to be improved by rehabilitation.

Soft tissue changes such as decreased flexibility of joints and muscles, muscle weakness, and decreased muscle endurance has been assumed to affect postural deformities in PD patients and interventions for soft tissue changes are usually adopted to PD patients with postural deformities. Trunk-specific training such as stretching and strengthening exercise in a functional context decrease trunk flexion angle and lateral trunk flexion angle while standing in PD patients with mild to severe lateral trunk flexion [17]. Physical rehabilitation including stretching and strengthening exercise of trunk and lower limb may reduce painful abdominal muscle contractions and improved lateral trunk flexion angle in PD patients with severe lateral trunk flexion [18].

Santamato et al. [13] reported that botulinum toxin injections into the paraspinal muscles and rehabilitation program consisting of stretching and agility exercise improve lateral trunk flexion angle in a PD patients with pisa syndrome. Furusawa et al. [10] reported that repeated lidocaine injections into external oblique muscle improved trunk flexion angle and was maintained for 90 days by additional subsequent daily rehabilitation program that emphasized trunk extension in PD patients with upper camptocormia. Combined treatment with rehabilitation and injections such as botulinum toxin and lidocaine could be a useful treatment strategy for PD patients with severe postural deformities such as pisa syndrome and camptocormia with abnormal activity of truncal muscles.

Proprioceptive disintegration could affect impaired vertical perception in PD patients with postural deformities, especially lateral trunk flexion. Lateral trunk flexion increased when PD patients with lateral trunk flexion closed their eyes [19]. This phenomenon supports the notion concerning the relationship between the proprioceptive disintegration and lateral trunk flexion in PD patients. Prolonged body tilt to one side induces a bias in the perception of body verticality, even in the healthy subjects [20]. Because PD patients with lateral trunk flexion that develops in the chronic fashion is tilted to one side for a long time, the perception of body verticality is assumed to be biased additionally.

Postural reeducation could improve trunk posture both in the frontal and sagittal planes to some extent [21]. Postural reeducation exercise aims to promote proper postural realignment in sagittal and frontal plane. Combination of postural reeducation exercise with intervention for proprioceptive discrimination exercise at the patients' back might additionally enhance their awareness of trunk position and promote adjustment. If PD patients could hardly correct postural abnormalities, physiotherapist might adopt compensatory devices such as truncal orthosis [22], high frame walker and backpack for camptocormia [23] and crutches for pisa syndrome. It is also important for physiotherapists to know these compensatory devices.

Limitations of previous studies and directions for future search

The characteristics of soft tissue changes have not been clarified, although the Interventions for soft tissue changes described above have been adopted in PD patients with postural deformities. In future studies, it should be that characteristics of soft tissue changes in PD patients with postural deformities are clarified and the interventions for soft tissue changes are selected in each PD patients with postural deformities. Moreover, the characteristics of the impairments of vertical perception remained to be clarified. Scocco et al. reported that both PD patients with and without pisa syndrome showed the deviations of vertical perception discussed these deviations cannot explain the lateral deviation of the posture in PD patients with pisa syndrome [24]. However, their study design was cross sectional, and the relationship between deviations of the vertical perception and pisa syndrome was inconclusive. Further, there has been no study investigating the vertical perception in the sagittal plane in PD patients with camptocormia. The perception of body verticality is important to generate motor program for the frontal and sagittal postural control. On the basis of understanding of the characteristics of vertical perception in PD patients with postural deformities, effective postural reeducation programs should be investigated in the future research.

Novel rehabilitation interventions and assessment methods for postural deformities

It was reported that PD patients with lateral bending posture have vestibular dysfunction which was ipsilateral to the leaning side [25]. The vestibular system detects angular and linear acceleration in the sagittal, frontal, and horizontal planes, and we hypothesized that vestibular function is bilaterally impaired in PD patients with anterior bending posture. Galvanic vestibular stimulation (GVS) is a method that stimulates vestibular system. Electrodes are attached to the mastoids behind the subject's ears to stimulate the vestibular system by low direct current. GVS has been used in neurophysiological experiments and otological tests [26]. Recently, there have been some reports in which GVS was used as an intervention strategy in PD patients and stroke patients with unilateral spatial neglect or pushing symptoms [27-30]. In our previous study we reported that binaural monopolar GVS, which stimulates with the cathode electrode of each pair over the mastoid process and the anode electrode over the trapezius muscle on the same side and likely activates both sides of vestibular system, improved the anterior bending angle in a PD patient with camptocormia [28]. Because this study was a single case study and did not compare with sham stimulation, the effects of GVS on camptocormia were not clarified.

Binaural bipolar GVS, which stimulates with the cathode over one side of the mastoid process and the anode over the other side of the mastoid process and activate vestibular system on the cathode side, shifts vertical perception of healthy subjects to the anode side during stimulation, but the shift was reversed toward the cathode side after the stimulation [31]. To improve lateral bending posture, binaural bipolar GVS might be better than binaural monopolar GVS. There is some possibility that GVS will be a novel intervention in PD patients with postural deformities. After the tendency of the bias of the vertical perception in PD patients with anterior bending posture and those with lateral bending posture are clarified, the effectiveness and of both types of GVS on these postural deformities and the appropriate stimulation method for each postural deformities should be investigated in the future study.

Visual feedback tools such as mirror, picture and video are applied in postural reeducation exercise described above, since the performance of postural orientation task is improved by using of the visual information in PD patients [32,33]. Augmented feedback is considered to be important for motor learning in the postural control task in PD patients [34]. Accordingly, we developed the system providing patients with augmented feedback in the form of the present anterior and lateral bending angles during training [35] (Figure 1). Test-retest reliability, concurrent validity, and accuracy of the system in measurement of anterior and lateral bending angle during standing were confirmed [36,37]. The system uses the Kinect sensor and detects posture without attaching sensors to user's body. Lower frequency of visual feedback about the knowledge of results is generally better to promote motor learning [38]. Conradsson et al. reported that highly challenging and progressive training for postural control was feasible in mild to moderate PD patients [39]. It might be better that the frequency of the visual feedback in our developed system is adjusted to motor learning process. The appropriate frequency of the visual feedback in the motor learning process needed to be investigated. By combining the system and information and communication technology, it becomes possible that patients perform visual feedback training to improve posture by themselves at home, and that healthcare professionals remotely check the implementation status and the results of visual feedback training and provide patients with advice or feedback about the results.

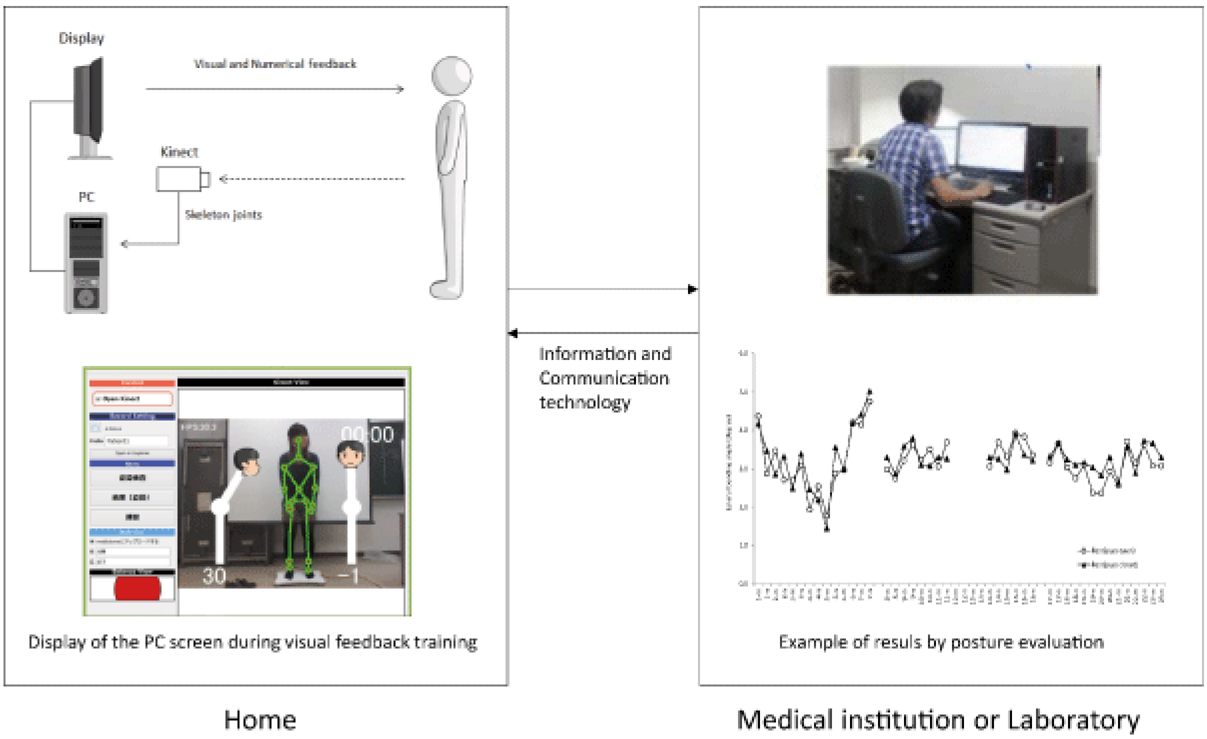

Figure 1: Schema of intercommunicate with persons in medical institution or laboratory and in-home patient who use Kinect-based system for posture evaluation and visual feedback training to improve sagittal and frontal posture.

Additionally, our developed system enables healthcare professionals to evaluate patients' anterior and lateral bending angles during standing at home. To date, healthcare professionals could not evaluate patient' posture at home after the discharge from the hospital or after the outpatient care, and patients could not convey the information about how their posture is at home. The system potentially solves these issues and provides novel forms of in-home rehabilitation and patient centered outcome that healthcare professionals really want to evaluate.

Conclusion

Interventions for soft tissue changes and postural reeducation exercise likely improve anterior and lateral bending posture. Since the causes inducing postural deformities are variable, and the appropriate interventions to individual PD patients with postural deformities should be selected on the basis of understanding the causes. Patient-tailored interventions based on the evaluation of causes of postural deformities, adopting new technology if necessary, are needed in future.

Acknowledgments

This work was supported by a Grant-in-Aid for Scientific Research from Japan Society for the Promotion of Science (No. 25750246; 23240028).

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