**CASE REPORT**

**An Intervention to Overcome Locomotion Difficulties in a Patient with Oculomotor Nerve Palsy: A Case Study**

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**Abstract:** Introduction: Diplopia due to restricted eye movements makes it difficult to locomote. There are no reported therapies that overcome the locomotion difficulties of patients with oculomotor nerve palsy after a stroke. We outline a therapy process conducted by an occupational therapist (OT) that combines ptosis therapy and the treatment of impaired eye movements with exploratory activities for locomotion that enabled the patient, a Japanese woman in her 70s, to improve her engagement in daily activities.

Methods: The OT therapy consisted of two phases. Phase I: Ptosis and eye movement interventions were performed. Phase II: Interventions supported locomotion that linked visual exploration and the somatosensory system, and the experienced locomotion was adapted to the environmental structure. The outcomes for the intervention effects were the degree of ptosis, eye movement and diplopia, gait functions, and a functional independence measure for activities of daily living.

Results: The patient's ptosis and eye movement disorder improved, and the difficulty of locomotion due to diplopia was overcome. She was thus able to become independent in all daily activities.

Conclusion: Therapy that combines interventions for ptosis and eye movement with exploratory activities supporting locomotion have overcome locomotion difficulties and improved the outcomes of patients with oculomotor nerve palsy. Current interventions may improve locomotion in post-stroke patients with oculomotor nerve palsy. Our findings led us to hypothesize that locomotion difficulties in patients with diplopia due to oculomotor nerve palsy can be overcome by combined therapy for ptosis and eye movements with support for exploratory action in locomotion.

Keywords: oculomotor nerve palsy, eye movement disorder, diplopia, locomotion, exploratory activities

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**Introduction**

About 60% of stroke patients experience visual impairment [1]. An unpleasant symptom of such impairment is diplopia [2], which is a cause of oculomotor nerve palsy. Its symptoms are associated with saccadic eye movement and gaze problems [2], and having diplopia makes locomotion in activities of daily living (ADLs) difficult. Eye-movement rehabilitation has been attempted [3, 4], but no optimal therapy is established.

Adaptive locomotion to the environment requires moving the gaze to explore the surrounding environment and associating self-movements [5]. Exploratory activities that link the surrounding environment with self-movement may thus facilitate locomotion, but this possibility is not verified. We describe an effective therapy comprised of combined therapies for ptosis and eye movements with exploratory activities for locomotion.

**Subject**

A Japanese woman in her 70s had experienced a brainstem infarction in the oculomotor nucleus area due to vertebral artery occlusion (Fig. 1). Cranial nerve findings showed ptosis of the left eye and movement disorders of the left eye’s upward adduction, adduction, upward abduction, and downward abduction, indicating...
left oculomotor nerve palsy. Eye-opening and eye-movement patterns required enhanced effort by excessive compensatory activity of the head/neck and facial muscles. The patient’s diplopia was severe based on her results on the Diplopia Questionnaire (www.pedig.net), which evaluates diplopia in ADLs on a 5-point scale. She had no physical paralysis, but her diplopia worsened with the changes in her binocular-vision gaze, and her mental and physical tension was constantly increasing. Her self-care ADLs could be performed with monocular vision (right eye), but the movements needed for toileting, bathing, and gait including locomotion were stagnant due to the diplopia’s worsening, and she needed a caregiver’s constant guiding.

Method

Therapy process

The interventions based on ptosis, eye movement, and exploratory activities for locomotion were divided into two phases and performed by an occupational therapist (OT): a 40-min therapy session each morning and a 60-min therapy session each afternoon, 5 days/week for 2 weeks. The two phases were performed consecutively in one therapy session. Phase I lasted 30 min, and Phase II lasted 10–30 min. The patient’s informed consent for this report was obtained.

Phase I: Ptosis and eye movements therapy

The OT adjusted the patient’s head/neck and facial muscle tone and facilitated selective movements with the aim of achieving independent eye-opening and eye movements. Using the vestibulo-ocular reflex is effective for facilitating eye movements for brainstem-derived eye movement disorders [3]. Therefore, the patient’s atlanto-occipital joint was quickly rotated to facilitate the saccadic eye movement in binocular vision (Fig. 2a).

Next, the OT administered an activity for approaching a visual object with the aim of enabling the patient to intentionally control her gaze from saccadic eye movement to the visual object (Fig. 2b). This intervention prepared the environment so that the patient’s gaze and body movements could be easily oriented by using the environmental structure, and the patient thus experienced locomotion linked with her gaze and her body movements.

Phase II: Locomotion therapy

The occluding edge was used to help achieve the patient’s locomotion adapted to the environmental structure; the ‘occluding edge’ refers to the edge of the surface structure of the environment, and it is a stimulus that changes the environment’s appearance with locomotion [6]. We speculated that the patient was unable to accept changes in visual stimuli during sensory reception because her diplopia increased her mental/physical tension. The OT thus oriented the patient’s locomotion by having her look to the occluding edge to enable her to pass through a gap while keeping her body in contact with the gap in the environmental structure (Fig. 2c).

Results

Table 1 summarizes the changes following the interventions. The patient’s ptosis and her levator muscle function improved, and there was almost no difference between the left and right eyes. The eye-movement disorder also improved, and the diplopia in ADLs was nearly eliminated. For this patient, even if diplopia occurs when she performs ADLs, the direction in which the diplopia occurs is now limited, and it has become possible to resolve the diplopia by self-adjustment.
Regarding her gait function, her tension about locomotion decreased and she became able to perform ADLs independently. Since she became able to conduct self-care activities with binocular vision, she overcame all difficulties involving locomotion.

**Discussion**

The patient had a midbrain infarction, and the symptoms of inferior rectus muscle and unilateral ptosis suggested oculomotor fascicle damage. In that lesion, the nerve fibers distal to ischemia are vulnerable, caus-
ing predominant damage to the extraocular muscles [7]. Since our patient had severe diplopia symptoms, she practiced ptosis and eye-movement therapy in Phase I. Although there is no therapy for ptosis to date, our patient’s results indicate that the adjustment of muscle tone and the facilitation of selective movements may have contributed to her recovery of levator muscle function. The eye-movement therapy used herein is based on the stimulation of the superior colliculus, which is involved in the execution of saccadic eye movement [1, 3]. This therapy assisted the movement of the gaze [8] and appears to have been appropriate.

To our knowledge, the Phase II exploratory activity described herein is the first therapy to provide a stimulus composed of vision and somatosensory information. Processes based on audiovisual stimuli are known to improve the accuracy of visual exploration [9]. The Phase II intervention’s effectiveness was suggested to involve learning transitions in exploratory activity [10], and somatosensory stimuli may have oriented our patient’s locomotion and facilitated visual exploration accuracy. However, spontaneous recovery from brain lesions can occur several months post-onset [1], and further research and a large patient series are required to validate the present interventions’ effectiveness. Moreover, the intervention conditions are limited to ptosis and eye-movement disorder without motor paralysis of limbs.

Conclusion

The combined interventions for ptosis, eye movements, and exploratory activities for locomotion helped a post-stroke patient with oculomotor nerve palsy overcome locomotion difficulty.

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