

Neurophysiological and Clinical Features of the Pusher Syndrome: Review Article



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Patients with the pusher syndrome show severe misperception of their own upright body orientation although visual vestibular processing is almost intact. They recognize their body as oriented upright when it is actually tilted nearly 20 degrees to the affected side. These patients resist any attempts to passively correct their tilted body posture towards an earth vertical upright orientation. They use the non-affected side arm and/or leg to actively push towards the affected side. Pusher syndrome patients have different prognoses and symptoms than general stroke patients without pusher syndrome. Pusher syndrome patients have a poor prognosis, so they need a long duration of treatment. Therefore, accurate diagnosis and proper treatment are important. In this study, we reviewed the symptoms, causes, evaluation, and treatment for pusher syndrome.

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I. Introduction

Human static posture is maintained through a program of central posture assisted by many sensorial modalities, vestibular, visual, muscular, cataneous and interoceptive origin. Additionally, the human body is stabilized by the interaction of these systems. However, in patients with brain injury, these systems are not normally performed.¹⁻³ In particular, in stroke patients, posture and balance impairment generally occur. Generally, stroke patients move their center of gravity towards the unaffected side. However, contrary to general postural strategy, some patients of stroke patients shift their center of gravity towards the affected side. Such specific postural disorder has been termed "pusher syndrome".^{4,5}

The pusher syndrome is associated with severe balance problem. Patients with pusher syndrome strongly resist attempts to correct the body toward the midline by external force.⁶ For example, patients with pusher syndrome push away actively the unaffected arm and/or leg from the non-paralyzed side, unlike typical stroke patients. Without assistance, this active pushing behavior leads to loss of postural balance and the patients fall

down towards the paralyzed side. Nevertheless, the patients more strongly resist any attempts to correct passively their tilted body posture towards the earth-vertical upright orientation. It turned out that patients with pusher syndrome suffer from a severely altered perception of the body's orientation in relation to gravity. Pusher patients experience their body as oriented 'upright' (subjective postural vertical, SPV) when actually tilted (about 18~20°) to the affected side.⁵

Causes of pusher syndrome were not clearly elucidated, and it has been reported that stroke patients with pusher syndrome have a variety of symptoms and prognosis. According to previous studies, Pederson et al.⁷ reported that prevalence of pusher syndrome reached 10.4%. Karnath et al.⁵ reported that patients with pusher syndrome had significant improvement in the recovery of strength in the affected leg, but not in the arm at 6 months.⁸ However, Taylor et al.⁹ found no significant difference between arm and leg. In addition, incidence of pusher syndrome differently occurs, according to damaged hemispheric side. Several previous studies suggested that pusher behavior was more observed in patients with right brain damage than in patients with left brain damage.

Previous studies reported that stroke patients with pusher syndrome had more long hospital stay and poor prognosis than typical stroke patients. The general treatment of stroke patients and patients with pusher syndrome are different. Therefore, accurate diagnosis of both symptoms is important for exact treatment. In the current study, we reviewed the causes, symptoms, evaluation, and treatment for pusher syndrome.

II. Symptoms

Successful balance performance requires the integration of intact motor and sensory processes. However, 88% of all patients experience hemiparesis and 53% have sensory deficits.¹⁰ Therefore, Steadiness, symmetry, and dynamic stability (components of balance) are all affected after stroke and those affected components contribute to overall disability.¹¹

In addition, patients with pusher syndrome show occasional symptoms. Patients with pusher syndrome show severe damage to the balance ability, and resistance to any external attempts to rectification.⁷ So, pushing behavior has been considered as one of the most intriguing disorders of postural control in patients with brain lesions. Therefore, the affected side limbs have a tendency toward flexed position, whereas the unaffected side limbs tend toward extended position. As a result, patients with the pusher syndrome move the center of gravity toward the paretic side, and without help of therapy or guardian, this active pushing leads to loss of postural balance and the patients fall down towards the paralyzed side. Moreover, the patients resist any attempts to correct passively their tilted body posture towards the midline. It revealed that patients with pusher syndrome suffer from a severely altered perception of the body's orientation in relation to gravity.⁵ They experience their body as oriented 'upright' (subjective postural vertical, SPV) when actually tilted in the coronal plane nearly 18~20° to the affected side. These symptoms appear while patients sitting or standing than when lying. When lying, movement of neck and head is more free.¹² Interestingly, these patients with pusher syndrome showed almost undisturbed processing of vestibular input and visual, which was well known as one of most important factors for normal balance performance.² Many previous studies suggested that patients with pusher syndrome have the wrong perception of body posture, not the visual and vestibular system.⁶ Mergner and

Rosemeier.² reported that pusher syndrome patients have a tilted body posture, but their visual and vestibular system function is normal.

Pusher syndrome appeared when either left or right brain is damaged. However, it appeared much often in the patients with right brain injury. The patients with pusher syndrome caused by right brain injury shows spatial neglect and anosognosia while aphasia appeared in the patients with pusher syndrome caused by left brain injury.⁵

III. Causes

Many researchers have been interested in the brain lesion areas where pusher syndrome occurs. Karnath et al.¹³ suggested that pusher syndrome is typically associated with posterolateral thalamus. However, pusher behavior was also observed in non-stroke patients with other brain injury or stroke patient without the thalamus. Thus, it could be argued that the posterior thalamus plays an important role of controlling upright body posture. Although such issue was controversial, Karnath et al.¹³ explained the relationship between pusher behavior and postlateral thalamic lesion as following. This disorder of upright body posture associated with thalamic strokes might be explained by the dysfunction of cortical areas rather than by the neuronal loss in the thalamus itself. However, it is not yet understood clearly. In fact, it has been revealed that thalamic infarctions and thalamotomy cause depressed levels of metabolic activity in the cerebral hemispheres thanks to using position emission tomography (PET).¹⁴ Thus, it is that the pusher patients with thalamic lesions have functional or metabolic abnormalities in cortical areas because of diaschisis or vascular dysfunction. These (distant) functional abnormalities have the patients induce misperception of body orientation. The present observation that contraversive pushing typically is due to hemorrhage (vs infarcts) and typically associated with a lesion of the posterior thalamus (vs anterior thalamic lesions in those patients without pushing behavior) thus are well consistent with these observations.

IV. Assessments

Patients with pusher syndrome usually spend long time staying

at a hospital for treatment. Also, poor prognosis has been reported.¹⁵ The methods of treatment for pusher syndrome are different from those for general stroke patients. Therefore, the exact treatment for a good prognosis is important to accurate assessment. Accurate assessment of pusher syndrome can shorten the treatment period and improve daily functioning ability goal of patients.¹⁶ Scale for contraversive pushing (SCP), Pusher index, Melbourne Pusher Scale, Lateropulsion Scale are specific tools for assessment of symptoms of pusher syndrome.¹⁷ In addition to functional behavior assessment, Functional Independence Measure (FIM), Modified Bathel Index (MBI) and Bohannon's Standing Balance Scale (BSBS) are used. However, these assessment tools have limitations. There are some obstacles of position sense such as proprioceptive problems, physiological problems. However, Scale for contraversive (SCP) is highly accurate and the reliability of assessment is widely used in clinical treatment.¹⁸

The contents of SCP is the following; (1) symmetry of spontaneous posture while sitting and standing, (2) the use of the nonparetic arm and/or leg to increase pushing force by abduction and extension of the extremities, and (3) resistance to passive correction of posture while sitting and standing. Patients were scored in the acute stage as having contraversive pushing, if all three criteria were presented, reaching a total score of at least 1 (max.=2, sitting plus standing) with respect to their spontaneous posture, at least a score of 1 (max.=2, sitting plus standing) concerning the use of the non-paretic arm and/or leg, and if they showed resistance to passive correction of posture while sitting or standing (i.e, at least a score of 1, max.=2, sitting plus standing). This SCP assessment has been several studies by the reliability test, the addition of several assessment tools have been used to evaluate the pusher syndrome.

V. Treatments

Symptoms of Patients with Pusher syndrome are different from those who without pusher behaviors and the treatment should also be done differently. It is very important to prevent the midline of patients with Pusher syndrome being toward affected side beyond the right center of gravity of the movement. That is, the center of the body should move toward unaffected side without resistance. Davies¹⁹ proposed a treatment: (1) Movement

recovery of the head inclined to the unaffected side. (Make the head free from the fixed location so that it can move to the direction of the affected side). (2) Maintaining upright position by using the functional movements. (3) Weight shifting to the unaffected side. (Make the patients reach for over the range of an arm span for weight shifting) (4) Stimulating the trunk flexor with lower muscle tone to arrange correctly. (5) Flexion toward unaffected side. (6) Getting the patients to maintain the posture as continuously as possible, with the trunk moving toward the given target. (7) Moving toward the front of the affected side. (8) Practicing gait exercise with the unaffected side contacting with a bed. (9) To practice climbing stairs. (10) Retraining balance response and knee extension in all positions. (11) Activating lateral flexors. (12) Leading to rearrangement of trunk on commands. (13) Giving patients a target point for elongation of trunk muscles.

Recently, more effective treatment based on previous therapeutic approaches has been suggested by Kanarth et al.⁵ 1) Realize the disturbed perception of upright body position. 2) Visually distinguish the surrounding from the body's relation to the surroundings. Make sure that the patients know whether he or she is oriented upright. Physical therapist use visual aids that give feedback about body orientation and perform in a room containing many vertical structures, such as door frames, windows, pillars, and so on. 3) Learn the movements that are necessary to reach a upright body position. 4) Maintain the upright body position while performing activities of daily living.

VI. Conclusion

Pusher syndrome appears in approximately 10~55% of patients with stroke. Now that, unlike typical stroke patients, patients with pusher syndrome have various symptoms and poor prognosis, they usually spend longer time staying at a hospital for treatment. Thus, precise evaluation which can lead to better prognosis and recovery is strongly required.

In the current review, we tried to clarify the essential factors such as the symptoms, causes, evaluation, and treatment that can provide the fundamental information for rehabilitation of patients with Pusher syndrome. In addition, adequate therapeutic interventions can provide patients with clinical criterion through that information.

Author Contributions

Research design: Kim JS

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