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Case Study

Prone positioning reduces severe pushing behavior: three case studies

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Abstract. [Purpose] Pushing behavior is classically described as a disorder of body orientation in the coronal plane. Most interventions for pushing behavior have focused on correcting the deviation in vertical perception. However, pushing behavior seems to involve erroneous movements associated with excessive motor output by the non-paretic limbs and trunk. The present study aimed to inhibit muscular hyper-activity by placing the non-paretic limbs and trunk in the prone position. [Subjects and Methods] The subjects of the present study were 3 acute stroke patients with severe pushing behavior. The study consisted of the following 3 phases: baseline, intervention, and follow-up. In addition to conventional therapy, patients received relaxation therapy in the prone position for 10 minutes a day over 2 days. The severity of pushing behavior was assessed using the scale for contraversive pushing, and truncal balance was evaluated using the trunk control test. These assessments were performed before and after the baseline phase, and after the intervention and follow-up phases. [Results] At the baseline phase, both scores were poor. Both scores improved after the intervention and follow-up phases, and all the patients could sit independently. [Conclusion] Relaxation therapy in the prone position might ameliorate pushing behavior and impaired truncal balance.

Key words: Pushing behavior, Prone position, Relaxation

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INTRODUCTION

Some stroke patients exhibit a so-called pushing behavior (PB). This behavior is characterized by a peculiar tendency to use the non-paretic limbs to actively push away from the non-paretic side in the coronal plane. Studies have shown that this behavior can adversely affect the functional outcome[1, 2)].

Karnath et al.[3)] suggested that PB might result from a mismatch between the normal visual vertical perception and the tilted orientation of a subjective body verticality. However, patients with PB sometimes resist transitive rolling over, suggesting that PB might be caused by not only by vertical mismatch, but also by excessive motor output by the non-paretic limbs and trunk. Postural reflexes are sometimes affected in stroke patients. The tonic labyrinthine reflex (TLR) is one of the postural reflexes, and it facilitates extensor muscle tone in the supine position, and flexor muscle tone in the prone position[4)]. In particular, the excessive motor output noted in cases of severe PB appears to be caused by abnormal postural reflexes in anti-gravity activities. Therefore, if PB is associated with the TLR, prone positioning might be useful for inhibiting the excessive motor output.

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Table 1. Patients' demography and characteristics

Case no.	Age (yrs)	Gender	Time after onset (d)	Diagnosis	Lesion area	BRS#	Severity of sensory loss*	Severity of unilateral spatial neglect*	MMSE†
1	60s	M	36	H	Putaminal (90cc)‡	II / I / II	severe	severe	17
2	70s	F	20	H	Putaminal (21cc)	III / II / III	moderate	moderate	15
3	70s	F	15	I	Middle cerebral artery (M1 occlusion)	II / I / II	moderate	moderate	25

BRS: Brunnstrom Recovery stage; MMSE: Mini Mental State Examination; F: female; M: male, I: Ischemia; H: intracerebral hemorrhage
#BRS, Upper extremity / Finger / Lower extremity.
*Evaluated by Stroke Impairment Assessment Set.
†Maximum score of 30 points (cutoff 23 points).
‡Received craniotomy for removal of hematoma.

In the present study, the hypothesis that PB might reduce if excessive motor output is restrained was tested by inhibiting muscular hyper-activity by placing the non-paretic limbs and trunk in the prone position.

SUBJECTS AND METHODS

The subjects of the present study were 3 acute stroke patients with severe PB. The patients also had hemiparesis and unilateral spatial neglect (USN). The subjects provided their written informed consent to take part in the study prior to its commencement, and the study procedures were performed in accordance with the Declaration of Helsinki.

A single case study design (ABA design) was applied to clarify the effects of the relaxation therapy in the prone position. The ABA design consisted of the following 3 phases: baseline, intervention, and follow-up. Each phase consisted of 2-day sessions conducted over 6 consecutive days. In addition to conventional therapy for PB, including visual feedback training, sit-to-stand training, and gait training with a knee-ankle-foot orthosis, patients received relaxation therapy in the prone position for 10 minutes a day. The relaxation therapy was performed using a treatment table (PM-213H; SAKAI Medical Corp., Tokyo, Japan). This treatment table had an opening for the face and had an adjustable headrest. Therefore, patients could remain in the prone posture comfortably without rotation or extension of the neck or trunk. The patients were placed in the prone position and then instructed to relax the neck, trunk, and limbs. Moreover, the body was shaken to reduce excessive muscle tone in the extensor muscles and to facilitate awareness of the excessive motor output. Then, feedback was provided on the difference between a relaxed state and excessive motor output.

The scale for contraversive pushing (SCP) was used to assess the severity of PB and the trunk control test (TCT) to assess truncal balance[5, 6]. The SCP has 3 subscales, and the total SCP score was determined by summing the scores of the 3 subscales (maximum score = 6 points). Patients were considered to have PB if they scored >0 points on any of the subscales[7], and severe PB was considered if the total score was 6 points. The TCT has 4 items, and the total TCT score is determined by summing the scores of the 4 items (maximum score = 100 points). The best truncal balance score is 100 points. Introspection regarding use of the non-paretic limbs and the subjective vertical body image in transitive vertical sitting were also checked. These assessments were performed before and after the baseline phase, and after the intervention and follow-up phases by one of the authors, who was not involved in the treatment.

RESULTS

The demographic and clinical characteristics of the patients are presented in Table 1. The results of the assessments are presented in Table 2. The SCP and TCT scores were poor during the baseline phase; however, these scores improved after the intervention phase, and all the patients could sit independently. These effects continued in the follow-up phase.

In introspection regarding usage of the non-paretic limbs, all the patients were unaware of the excessive reaction during the baseline phase. However, their recognitions were accurate after the intervention phase. Their subjective vertical body images were inclined in all of the phases.

DISCUSSION

The present study found that relaxation therapy in the prone position reduced PB immediately and continuously. Moreover, this treatment ameliorated the issues with truncal balance.

Paci et al.[8] reported that treatment using visual or auditory feedback resulted in immediate positive effects for a sub-acute stroke patient. Their patient underwent physiotherapy over a 3-week period, and the SCP score improved from 4.75 points

Table 2. Changes in scores and introspection

		Before baseline	After baseline	After intervention	After follow-up
Scale for Contraversive Pushing					
	Case 1	6	6	3.5	3.5
	Case 2	6	6	2.5	1.75
	Case 3	5.5	5.5	2.5	3.5
Trunk Control Test					
	Case 1	12	12	24	24
	Case 2	12	12	24	24
	Case 3	0	0	12	12
Introspection about usage of non-paretic limbs#					
	Case 1	"I do not push my non-paretic limbs."		"I noticed that I had been pushing excessively."	
	Case 2				
	Case 3				
Introspection in the sitting posture upright passively#					
	Case 1	"My body inclines and seems to fall down."		Their introspection was not changed.	
	Case 2				
	Case 3				

the three cases had similar introspection.

to 2.75 points. Krewer et al.[9] compared the immediate after-effects of 3 different interventions (20 minutes per session) for PB in a cross-over trial. Their results showed that the reduction in PB was significantly greater with machine-supported gait training than with physiotherapy involving visual feedback components. The immediate benefits were noted only on the Burke Lateropulsion Scale, which can detect smaller changes than the SCP.

Although many previous studies have attempted to realign deviated vertical perception using visual cues[8–10], no study noticed inhibition of excessive motor output with prone positioning. Therefore, our strategy of prone positioning is a novel intervention strategy for patients with severe PB. The patients could sit independently after the intervention; however, their inclined subjective vertical body images did not change. These results suggest that prone positioning influences motor output rather than vertical perception. It is known that stroke patients are likely to have unbalanced interhemispheric inhibitions, such as excessive non-paretic limb activity[11]. The TLR inhibits extensor muscle tone in the prone position[4]. Saj et al.[12] reported that USN affected visual vertical perception. Our patients had severe hemiparesis and USN in addition to severe PB. Therefore, these patients might have had issues with reflexive or involuntary reactions rather than vertical perception in postural control.

The present results were obtained from only 3 stroke patients with severe PB. In addition, this study did not assess changes in muscle tone. Therefore, future studies should include examination of muscle tone with a larger number of patients with different PB severities. Moreover, further studies are needed to investigate the physiological mechanisms of PB reduction in the prone position.

In conclusion, relaxation therapy in the prone position might reduce PB immediately and continuously. Moreover, this treatment might ameliorate issues with truncal balance.

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