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Case Report

성인 뇌성마비 환자에서 경막내 바클로펜 주입 후 용량 의존적 보행 양상 변화 —증례 보고—

[1]연세대학교 의과대학 재활의학교실 및 재활의학연구소, [2]연세대학교 의과대학 의과학과 BK 21 플러스 의과학사업단, [3]연세대학교 의과대학 신경외과학교실, [4]연세대학교 의과대학 에비슨의생명연구센터, [5]연세대학교 의과대학 신경근육질환 재활연구소

신윤겸[1,2] · 김애령[1] · 장진우[3] · 장원석[3] · 이돈신[1] · 조성래[1,2,4,5]

Dose-dependent Changes in Gait Pattern after Intrathecal Baclofen Bolus Injection in Adult Ambulatory Cerebral Palsy —A Case Report—

Yoon-Kyum Shin, P.T., M.S.[1,2], Ae Ryung Kim, M.D.[1], Jin Woo Chang, M.D., Ph.D.[3], Won Seok Chang, M.D., Ph.D.[3], Don Shin Lee, B.S.[1], Sung-Rae Cho, M.D., Ph.D.[1,2,4,5]

[1]Department and Research Institute of Rehabilitation Medicine, Yonsei University College of Medicine, [2]Brain Korea 21 PLUS Project for Medical Science, Yonsei University College of Medicine, [3]Department of Neurosurgery and Brain Research Institute, Yonsei University College of Medicine, [4]Avison Biomedical Research Center, Yonsei University College of Medicine, [5]Rehabilitation Institute of Neuromuscular Disease, Yonsei University College of Medicine

Intrathecal baclofen (ITB) therapy has been proven to reduce severe spasticity in cerebral palsy (CP). However, few results reported the objective gait pattern change after ITB bolus injection in adult ambulatory CP. We therefore evaluated observational and kinematic gait patterns at different ITB bolus injection doses. We performed a test trial of 3-day ITB bolus injections at doses of 12.5 μg, 25 μg, and 50 μg in ambulatory CP. We evaluated modified Ashworth scale, visual analogue scale, observational gait scale, and kinematic gait analysis after ITB bolus injection. Intrathecal administration of low-dose baclofen 25 μg was successfully used not only for the treatment of spasticity but also for the treatment of gait disturbance, whereas the higher dose baclofen 50 μg induced foot drop and deteriorated gait pattern. We experienced dose-dependent changes in gait pattern confirmed by the observational and kinematic gait assessments after ITB bolus injection in adult ambulatory CP. **(Brain & NeuroRehabilitation 2015; 8: 104-108)**

Key Words: baclofen, cerebral palsy, gait

Introduction

Spasticity is increased muscle tone commonly accompanying neurological conditions such as cerebral palsy (CP) and brain injury. Spasticity of lower extremities attributes to hip/knee flexed and toe-walking gait. This deviation of gait pattern is correlated with the amount of spasticity and functional level.[1] For the treatment of spasticity, various therapeutic options can be considered to reduce spasticity and improve motor function. Although oral medications such as baclofen, diazepam, dantrolene, and tizanidine may help to reduce muscle tone, many patients experience systemic adverse events associated with these agents. Injection of botulinum toxin, phenol, and alcohol may temporarily reduce spasticity, and are particularly useful for patients with focal spasticity. For spasticity that does not respond to these treatments, selective posterior rhizotomy (SPR) or intrathecal baclofen (ITB) therapy can be considered as therapeutic strategies. In addition, orthopedic surgery has an important role in the treatment

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Correspondence to: Sung-Rae Cho, Department and Research Institute of Rehabilitation Medicine, Yonsei University College of Medicine, 50 Yonsei-ro, Shinchon-dong, Seodaemun-gu, Seoul 03722, Korea
Tel: 02-2228-3715, Fax: 02-363-2795
E-mail: srcho918@yuhs.ac
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of the musculoskeletal deformities and contractures by musculotendinous lengthening, tendon transfer, and derotation osteotomies.[2]

Contrary to orthopedic surgery and SPR, ITB therapy allows for reversible treatment of spasticity and modulation of muscle tone to effectively reduce severe spasticity that is intractable to oral medicine.[3] Before the placement of the baclofen infusion pump, a preliminary test is necessary to ensure the safety, efficacy and drawbacks of ITB therapy in candidate patients because ITB may induce various adverse events such as headache, nausea, vomiting, dizziness, respiratory suppression, seizure and loss of consciousness. Above all, reduction of spasticity by ITB bolus infusion is not always followed by improvement of gait function.[4] In patients with ambulatory CP, in particular, reduction of spasticity in leg muscles may rather induce muscle weakness and gait disturbance.[5] However, few results have been reported regarding the objective gait pattern changed according to the amount of the ITB bolus injection in adult ambulatory CP.

Here, we present dose-dependent changes in observational and kinematic gait patterns in an adult patient with ambulatory CP who underwent ITB bolus injection as a test trial for the treatment of spasticity and gait disturbance, thus allowing for the prediction of how a patient would respond to the ITB bolus injection. This study suggests that ITB bolus injection can be carefully applied in adult ambulatory CP with spastic gait pattern.

Case Report

A 40-year-old man who was born prematurely at 27 weeks gestation with a weight of 2.2 kg was diagnosed with CP spastic diplegia at 1 year after birth. He visited the outpatient clinic for the management of spasticity and gait disturbance. He also suffered from pain in the lower back and both posterior thighs with a visual analog scale (VAS) of 7 scores. Although he has been treated with motor point block and medial branch block, these have provided temporary improvements in pain. He received the treatment in the pain clinic 2 weeks before the ITB bolus injection.

He could walk independently and do most activities of daily living with modified Barthel index (MBI) of 100 scores, functional independence measure (FIM) of 126 scores, gross motor function classification system (GMFCS) level I and manual ability classification system (MACS) level I. However, hip internal rotated, hip flexed, knee flexed, ankle dorsiflexed, ankle pronated and toe-in gait pattern was observed with spasticity of both legs, 30 degrees of femoral anteversion, and 40 degrees of tibial torsion. The patient has daily received oral medications such as baclofen 30 mg, dantrolene 75 mg, and tizanidine 3 mg. Lower limb spasticity became worsen when administration of these drugs was stopped. According to the modified Ashworth scale (MAS), the grade of spasticity was 1+ in both hip flexors, 1+ in left knee flexors, 1 in right knee flexors, 2 in left ankle plantar flexors and 1+ in right ankle dorsiflexors (Table 2). In the manual muscle test (MMT), the muscle strength was 4 in both hip flexors, 3 in both hip extensors, 4 in both knee flexors and extensors, 3 in both ankle dorsiflexors, and 3 in both ankle plantar flexors.

In the kinematic gait analysis performed before the ITB bolus injection, anterior pelvic tilt was increased in the sagittal plane, and pelvic bump sign was observed, which shows no pelvic and hip movement dissociation. In the transverse plane, external rotation of the right pelvis and internal rotation of the left pelvis were observed. In the sagittal plane, knee flexion was seen in the overall gait cycle due to the spasticity of the hamstring muscles (Fig. 1A).

Because this patient was considered to be a candidate for the ITB therapy, he was given a test dose of ITB bolus injection to assess the response and adverse events. Oral medications were discontinued 3 days before the ITB test trial. On the first day of the procedure, baclofen 12.5 μg was administered via a lumbar puncture. The patient was on bed rest for at least for 3 hours following the procedure. Vital signs such as blood pressure, heart rate, and respiratory rate, and adverse events were monitored after the procedure (Table 1).[6] Although there was no improvement in terms of the MAS for grading spasticity, discomforts the patient experienced at the initiation of gait were subjectively improved and the pain in the lower back and posterior thigh were markedly reduced (Table 2). The next day, the patient received 25 μg of ITB, and video-based observational gait analysis was performed at 4 hours after the procedure. Spasticity was reduced to MAS grade 1 in both hip flexors and 1^+ in the left ankle plantar flexors (Table 2). On the third day, 50 μg of baclofen was administered, and observational and kinematic gait analyses were performed at 4 hours after the procedure.

Briefly, observational gait scale (OGS) of each leg was assessed before the procedure and after the intrathecal bolus injections of 25 μg and 50 μg baclofen, and these were compared to analyze the patient's response (Table 3).[7] OGS was improved with the administration of 25 μg baclofen (left 17 scores, right 16 scores) compared

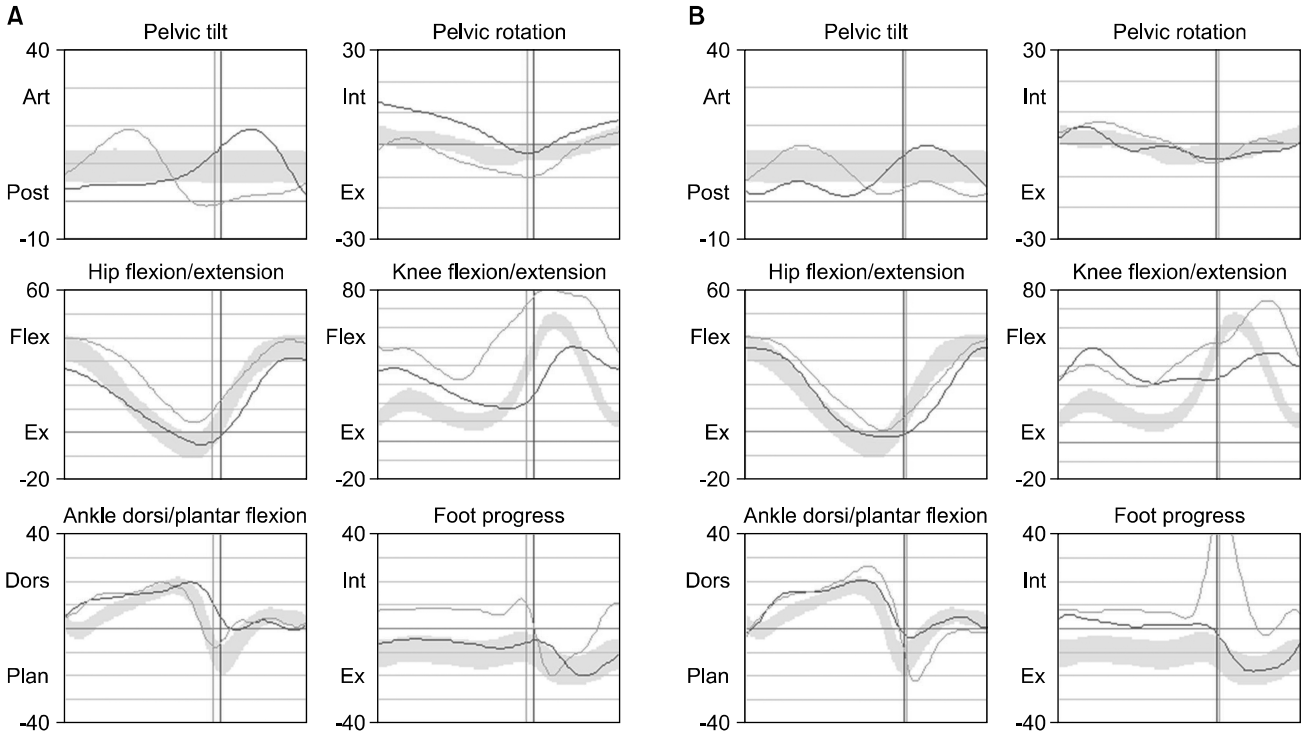

Fig. 1. Kinematic change in gait analysis after the intrathecal bolus injection of 50 μg baclofen. When compared with before injection (A), after intrathecal bolus injection of 50 μg baclofen (B), pelvic anterior tilt was decreased at the sagittal plane and asymmetric pelvic rotation improved at the transverse plane. Knee flexion was also decreased in the swing phase at the sagittal plane. However, the patient showed right foot drop and foot internal rotation was appeared after injection at swing phase.

Table 1. Side Effects Observed During the Intrathecal Baclofen Bolus Injection Trials

Scale	Before injection	1st day	2nd day	3rd day
Baclofen dose (μg)	-	12.5	25	50
Muscle weakness	-	-	-	+
Somnolence, Drowsiness	-	-	-	-
Nausea, Vomiting	-	-	-	-
Headache	-	-	-	-
Dizziness	-	-	-	-
Respiratory depression	-	-	-	-
Seizure	-	-	-	-
Loss of consciousness	-	-	-	-

Table 2. Comparison of the Patient's Responses to the Intrathecal Baclofen Bolus Injection Trials

Scale	Before injection	1st day	2nd day	3rd day
Baclofen dose (μg)	-	12.5	25	50
Spasticity (MAS)				
Rt. hip flexors	G1+	G1+	G1	G1
Lt. hip flexors	G1+	G1+	G1	G1
Rt. knee flexors	G1	G1	G1	G1
Lt. knee flexors	G1+	G1	G1	G1
Rt. ankle PF	G1+	G1+	G1+	G1+
Lt. ankle PF	G2	G2	G1+	G1+
Pain (VAS)	7	1	0	0

MAS: Modified Ashworth scale, VAS: Visual analogue scale, PF: Plantar flexor, DF: Dorsiflexor.

to baseline (left 14 scores, right 15 scores). However, these gait patterns were aggravated after the intrathecal bolus injection of 50 μg baclofen (left 16 scores, right 11 scores). In particular, kinematic gait analysis at 4 hours after intrathecal bolus injection of 50 μg baclofen showed that pelvic anterior tilt was decreased at the sagittal plane and asymmetric pelvic rotation improved at the transverse plane. Knee flexion was also decreased in the swing phase at the sagittal plane. However, for the right ankle joint, foot drop pattern appeared at the swing phase, and foot internal rotation was aggravated. Namely, ankle dorsiflexion weakness presented as decreased foot clearance and right foot internal rotation to compensate the foot drop was shown (Fig. 1B).

Discussion

In patients with CP, spasticity of lower extremities frequently causes deterioration of gait pattern.[1] Although these may have negative

Table 3. Comparison of the Observational Gait Scale to the Intrathecal Baclofen Bolus Injection Trials

Gait parameter	Definition	Left leg			Right leg		
		Before injection	2nd day	3rd day	Before injection	2nd day	3rd day
1.Knee position in midstance	Crouch Severe >15						
	Moderate >10 to 15	1			1	1	
	Mild <10		2	2			2
	Neutral						
	Mild<5						
	Recurvatum Moderate 5-10						
	Severe >10						
2. Initial foot contact	Toe						
	Forefoot	1					
	Foot-flat		2	2	2	2	2
	Heel						
3. Foot contact at midstance	Toe/toe (equinus)						
	Foot-flat/early heel rise						0
	Foot-flat/no early heel rise	1	1	1	1	1	
	Occasional heel/foot-flat						
	Heel/toe (normal roll-over)						
4. Timing of heel rise	No heel contact (fixed equinus)						
	Before 25% stance (very early)						
	Between 25-50% (slightly early)						2
	At terminal stance	3	3	3	3	3	
	No heel rise (after foot-flat, i.e., crouch)						
5. Hindfoot at midstance	Varus						
	Valgus	1			1		1
	Neutral		2	2		2	
6. Base of support	Frank scissoring						
	Narrow base (poor knee clearance)						
	Wide base		2	2		2	2
	Normal base (width of shoulders)	3			3		
7. Gait assistive devices	Walker (forward/posterior) with assistance						
	Walker (independent)						
	Crutches, sticks						
	None, independent for 10 m	3	3	3	3	3	3
8. Changes	Worse						−1
	None	1		1	1		
	Better		2			2	
Total		14	17	16	15	16	11

impacts on pain, hygiene, sleep patterns, and activities of daily living, oral medications and botulinum toxin injection therapy are insufficient to effectively manage these symptoms in many patients with severe spasticity. Previous study showed that administration of ITB may improve motor control in patients with ambulatory CP and have suggested that early placement of the ITB infusion pump is required for the prevention of orthopedic deformities and joint contracture.[8]

In this case report, we observed changes in neurological signs and musculoskeletal symptoms such as spasticity, pain, and gait pattern after intrathecal bolus injection of low-dose baclofen. This showed that the ITB therapy may be effective for the management of spasticity, chronic pain, and gait disturbance. On the other hand, considering that spasticity has occasionally a positive impact in the clinical field and that spasticity may help to stabilize gait and compensate for muscle power, the reduction of spasticity is not always followed by improvement in function.[9] Therefore, in adult ambulatory CP, it is important to test a patient's gait pattern and functional changes with ITB bolus injection before the placement of the ITB infusion pump.

The patient expressed subjectively reduced muscle tone during dynamic gait on the first day of 12.5 μg ITB test trial, whereas there was no objective change in the MAS for grading spasticity. Moreover,

the patient was subjectively the most satisfied and spasticity was also objectively reduced on the second day, when 25 μg of baclofen was administered. However, the patient showed foot drop pattern during gait after injection of baclofen 50 μg. In the observational and kinematic gait assessments, foot drop were observed without maintenance of right ankle dorsiflexion during swing phase of gait cycle. Accordingly, the negative change of gait pattern with more than 50 μg daily infusion dose of ITB pump could be estimated using the ITB bolus injection in this patient.

Surprisingly, chronic pain in the lower back and posterior thigh improved from initial VAS score 7 to VAS score 1 after the intrathecal bolus injection of low-dose baclofen 12.5 μg, and then resolved after the administration of 25 μg baclofen. This suggests that ITB therapy may contribute to the improvement of secondary pain by controlling the spasticity[6] and GABA-mediated analgesic modulation.[10]

In summary, we estimated the response with a baclofen infusion pump using the test dose of ITB bolus injection in a patient with ambulatory CP who had spasticity, musculoskeletal pain, and gait disturbance. The patient was generally satisfied and felt comfortable walking during gait with a low-dose ITB bolus injection, namely 25 μg baclofen. Chronic pain in the lower back and in both legs was also dramatically reduced. However, maintenance of ankle dorsiflexion during swing phase of gait cycle was difficult after the intrathecal bolus injection of 50 μg baclofen. This suggests that fine control of the ITB dosages is essential to optimize the degree of spasticity to avoid deterioration in gait pattern.

Conclusion

We experienced dose-dependent changes in gait pattern confirmed by the observational and kinematic gait assessments after the ITB bolus injection in an adult patient with ambulatory CP. Characteristically, intrathecal administration of the low-dose baclofen could be successfully used not only for the treatment of spasticity and musculoskeletal pain but also for the treatment of gait disturbance, whereas the higher dose baclofen could induce foot drop and deteriorate gait pattern and potentially functional deterioration in adult ambulatory CP.

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