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The Effect of Obturator Nerve Block on Hip Lateralization in Low Functioning Children with Spastic Cerebral Palsy

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Purpose: Hip adductor spasticity has a great impact on developing hip displacement in children with cerebral palsy (CP). Obturator nerve (ON) block is less invasive intervention rather than soft tissue surgery for reduction of hip adductor spasticity. The aim of this study is to investigate the effect of ON block on hip lateralization in low functioning children with spastic CP. **Materials and Methods:** The study was performed by retrospective investigation of the clinical and radiographic follow-up data of low functioning children [gross motor function classification system (GMFCS) level III to V] with spastic cerebral palsy whose hip was subluxated. Migration percentage (MP) was measured on hip radiographs and its annual change was calculated. In intervention group, ON block was done with 50% ethyl alcohol under the guidance of electrical stimulation. **Results:** The data of 49 legs of 25 children for intervention group and the data of 41 legs of 23 children for nonintervention group were collected. In intervention group, the MP were significantly reduced at 1st follow-up and the MPs at 2nd and last follow-up did not show significant differences from initial MP. Whereas in nonintervention group, the MPs at 1st, 2nd and last follow-up were all significantly increased compared to initial MPs. **Conclusion:** ON block with ethyl alcohol is useful as an early effective procedure against progressive hip displacement in these children with spastic CP.

Key Words: Cerebral palsy, hip dislocation, nerve block, obturator nerve

INTRODUCTION

Cerebral palsy (CP) is the most common neurologic disorder that causes chronic disability in children. Spastic CP is the most common type of CP, and frequently leads to the development of progressive contractures and bony deformities. Moreover, hip displacement is one of the most common problems in the lower limbs after equinus foot.[1] The incidence of hip dislocation is related to the severity of motor involvement.[2-5] Hip dislocation is seen in up to 60% of children with total body involvement, whereas it goes down to 7% in ambulatory children with CP.[6,7] A population study found that 54% of children who were not able to walk independently had unilateral or bilateral hip subluxation.[2] If left untreated, hip subluxation can progress to dislocation, leading to serious problems such as pain, gait disturbances, difficulty sitting, and problems with perineal hygiene.[8]

A hip surveillance program is recommended for early identification of hip displacement and early intervention to reduce the need for invasive reconstructive and salvage surgery. Radiologic measurements are commonly used for monitoring hip displacement. Reimer's migration percentage (MP)[9] is a valid and reliable measure of lateral hip displacement and the most commonly used radiologic parameter.[10-14]

Because spasticity of the hip adductor has the greatest impact on hip displacement in children with CP,[15,16] early surgical adductor release has been largely used for alleviating progressive hip subluxation in children with CP. Recently, botulinum toxin type-A (BoNT-A) injection into hip adductor muscles has been tested for alleviating progressive hip displacement and has shown some beneficial effects in alleviating hip lateralization along with reducing hip adductor spasticity.[6,17,18] In addition, children with low gross motor function, as determined by the gross motor function classification system (GMFCS; levels III to V), have poorer results in alleviating progressive hip dislocation after BoNT-A injection compared to children with high function at GMFCS levels I and II.[6] The obturator nerve (ON) block is also considered an effective intervention for reducing hip adductor spasticity.[19,20] Compared to BoNT-A, the ON block is less expensive. However, the effect of ON block on hip lateralization has not been investigated in children with CP. Therefore, the aim of this study was to investigate the effect of an ON block on hip lateralization in children with spastic CP with low function at GMFCS levels III to V.

MATERIALS AND METHODS

Patients

Medical records of children with CP who had radiographic hip surveillance between May 2006 and December 2008 were retrospectively reviewed. Among those cases, children who met the following inclusion criteria were selected: 1) children with bilateral spastic CP whose functions were at levels III to V based on the GMFCS,[21] 2) children whose first hip radiographs were taken younger than 6 years of age, 3) children in whom radiographs of the hips were taken at least three times with intervals of more than 6 months, 4) children with hip MP between 20% and 60%, and 5) children with hip adductor spasticity ≥2 on the Modified Ashworth Scale. Children were excluded if they had previous orthopedic surgery or any chemoneurolysis within 6 months before the first hip radiographs. Among children who met the above criteria during the same time period, children who received an ON block were recruited as the intervention group and children who had not received any chemoneurolytic intervention (ON block or BoNT-A injection into hip adductor muscles), due to various reasons such as parental disagreement or burden of general anesthesia, were recruited as the nonintervention group. Hip orthoses were not applied to children of either group. Since the outcomes following soft tissue surgery for spastic hip subluxation are poor in cases with an initial MP of more than 60%[22-28] and soft tissue surgery is seldom indicated if MP is equal to or more than 60% due to the high failure rate of the surgical procedure,[29] an ON block was performed only if MP was less than 60%.

Methods

Radiographs were obtained in a standard position.[2] MP was measured by calculating the percentage of the femoral head that lies outside the lateral border of the acetabulum, which was defined by bony landmarks on pelvis anteroposterior radiographs.[10] Because the duration between initial radiographs and follow-up radiographs was not the same among the children, the annual changes in MP (percentage/year) were calculated, with the interval changes in MP divided by duration (years).

ON blocks were performed using the inguinal approach described by Choquet, et al.[30] under general anesthesia. Choquet, et al.[22] reported that the inguinal approach can block both anterior and posterior branches of the ON easier and more successfully with a lower risk of complications compared to the pubic approach. Ethyl alcohol (50%) was injected to block both the anterior and posterior branches of the ON bilaterally. Overall, 1 to 3 mL of ethyl alcohol was used to block each side of the ON according to the patient's body weight and the spasticity of the hip adductors.

In the intervention group, hip adductor spasticity was assessed with the Modified Ashworth[18] and Modified Tardieu[31] Scales that measure the angle of muscle catch on the fastest movement (R1) and the passive range of motion (R2), before injection as well as 3 and 6 months after injection.

This study was conducted with the approval of our Institutional Review Board (4-2008-0605).

Statistics

Between the intervention and nonintervention groups, the numerical parameters were compared using independent t-tests, and nominal data were compared using chi-square

Table 1. General Characteristics

	Intervention group (n=49 hips)	Nonintervention group (n=41 hips)
Sex (female/male, n)*	33/16	18/23
GMFCS (III : IV : V, n)	(18 : 17 : 14)	(17 : 15 : 9)
Initial age (mean±SD, months)	54.17±16.45	48.18±14.15
1st follow-up period (months)	7.23±4.13	7.60±2.13
2nd follow-up period (months)	15.57±7.11	16.03±4.30
Last follow-up period (months)	18.46±6.50	20.10±5.60

SD, standard deviation; GMFCS, gross motor function classification system.
Follow up period is the length of time from the day when the initial migration percentage was measured. Comparisons were made by chi-square test and independent t-test.
*p<0.05 with the chi-square test.

tests. A linear mixed-effect model with repeated measures was used to evaluate group differences in repeated MP measurements on the following factors: treatment, time, and treatment by time interaction with compound symmetry covariance structure. Two-sided p-values <0.05 were considered statistically significant. All data were analyzed using PASW for Windows (SPSS Inc., Chicago, IL, USA).

RESULTS

A total of 49 legs from 25 children and 41 legs from 23 children were enrolled as the intervention and the nonintervention groups, respectively. We did not find any significant differences in the distribution of GMFCS, initial age of hip radiograph, or the follow-up period between the groups (p>0.05). The mean duration between the initial exams and the first follow-up exams were 7.23 months and 7.60 months in the intervention and nonintervention groups, respectively, and the mean duration between the initial exams and the final follow-up exams were 18.46 months in the intervention group and 20.10 months in the nonintervention group. The duration between the initial exam and each follow-up MP measurements were not significantly different between the intervention and nonintervention groups (p>0.05) (Table 1).

Initial MPs were not different between the intervention and nonintervention groups. In the intervention group, the mean MP at the first follow-up exam was less than the initial mean MP, and mean MPs at the second and final exams showed no difference from the initial MP after ON block. In the nonintervention group, mean MPs at all follow-up exams were greater than the initial mean MPs (p<0.05) (Table 2).

In this study, negative values for annual MP changes indicated improvement in hip displacement, and positive values indicated progressive hip displacement. The annual MP showed a statistically significant difference between the intervention and nonintervention group by linear mixed model (p=0.002). The annual MP during the first and second follow-up exams in intervention group showed interval improvement in hip displacement whereas the annual MP showed interval aggravation of hip displacement in nonintervention group (Table 3).

Table 2. MPs at the Initial Visit and Each Follow-Up Visit

MP	Intervention group	Nonintervention group
Initial	39.65±12.74	35.07±9.44
1st follow-up	36.64±12.42*	37.68±14.28†
2nd follow-up	38.56±13.20	38.02±14.80†
Last follow-up	41.23±16.00	38.27±14.76†

MP, migration percentage.
Values are mean±SD%.
*p value <0.05 with the paired t-test between initial and 1st follow-up in the intervention group.
†p value <0.05 with the paired t-test between initial and each follow-up in the nonintervention group.

In the intervention group, the spasticity of the hip adductor muscles, as measured with the Modified Ashworth and Modified Tardieu Scales, was significantly reduced following ON block, and it lasted at least 6 months (Table 4).

DISCUSSION

In terms of hip displacement, we found significant improvement in hip lateralization after ON block at the first follow-up exam. Despite our patient's poor walking ability, the significant reduction in hip displacement following ON block suggested that an ON block may be an effective therapeutic intervention for alleviating hip displacement on a short-term basis. In addition, the significant differences in the annual changes in MPs at the second follow-up exam between the two groups seems to be caused by the carry-over effects of the initial reduction of hip displacement in the intervention

Table 3. Comparison of MP Changes between the Intervention and Nonintervention Groups

MP	Intervention group (n=49)	Nonintervention group (n=41)
Change (%)	1.59±9.45	3.20±9.32
1st follow-up annual change (%/yr)	-12.41±30.93	4.23±12.31
2nd follow-up annual change (%/yr)	-1.22±7.26	2.33±7.43
Last follow-up annual change (%/yr)	1.09±7.63	2.35±6.85

MP, migration percentage.
Values are mean±SD. A positive number in the annual change indicates worsening, and a negative number indicates improvement in MP. 1st follow-up annual change=(1st follow-up MP-initial MP)/period of 1st follow-up since initial MP measurement. 2nd follow-up annual change=(2nd follow-up MP-initial MP)/period of 2nd follow-up since initial MP measurement. Last follow-up annual change=(last follow-up MP-initial MP)/period of last follow-up since initial MP measurement.

Table 4. Changes in Hip Adductor Spasticity in the Intervention Group

Assessment	Knee position	Preinjection	1st follow-up (3 months after ON block)	2nd follow-up (6 months after ON block)
MAS	Flexion	2.38±0.57	1.54±0.58*	1.63±0.65
	Extension	3.35±0.85	2.31±0.84*	2.17±0.87*
MTS				
R1	Flexion	29.62±13.11	43.65±12.29*	40.00±13.35*
	Extension	10.38±5.82	27.31±12.35*	21.67±10.60*
R2	Flexion	52.88±12.18	63.46±12.23*	62.08±11.51*
	Extension	24.04±8.37	39.23±10.93*	38.96±9.67*

MAS, Modified Ashworth Scale; MTS, Modified Tardieu Scale; R1, angle of muscle catch on fastest movement; R2, passive range of motion of hip abduction; ON, obturator nerve.
Values are mean±SD. Preinjection, baseline data before ON block.
*$p<0.05$ with the paired t-test between preinjection and follow-up.

group. However, a single ON block did not result in a significant difference in hip displacement between the groups for the long term. MPs can be kept stable for over 2 years with BoNT-A injections every 12 weeks, even in CP patients with a high risk for hip dislocation.[17] In our study, the effect of the ON block lasted over 6 months in both clinical and hip lateralization. However, it is unknown whether ON block can ultimately prevent the development of hip dislocation in these low-functioning CP children if ON block is repeated every 6 months. Further studies involving long-term follow-up are needed.

This study showed favorable effects of ON block on hip displacement compared to the nonintervention group. In general, early treatment is preferable for maximum responses and prolonged effects. Thus, the favorable effects seen in our study were likely influenced by early intervention during the course of hip displacement. The risk of progressive hip displacement and dislocation is known to be high in patients with poor walking ability,[32-37] like our patients. Despite the high risk, the lower annual changes in MP until the second follow-up exam in the intervention group suggested that ON block with ethyl alcohol is useful as an early intervention for alleviating progressive hip displacement in these low-functioning children with CP.[38-43]

This was a retrospective study. As a result, some differences may exist between the two groups in various areas such as economic background, the patient's general health status, existing family problems, frequency of other treatments, and the parents' abilities/attitudes about taking care of their child, which may have influenced the outcomes. A further prospective randomized controlled study is needed to avoid this limitation of our study.

In conclusion, compared to initial MPs, the mean MPs at the first follow-up exam was significantly reduced in the intervention group, whereas the MP was significantly increased in the nonintervention group. In addition, the annual changes in MP were lower until the second follow-up exam in the intervention group compared to the nonintervention group. Despite the low functional level of our patients, a favorable effect of ON block with ethyl alcohol for alleviating progressive hip displacement suggests that it is useful as an early intervention for alleviating further hip displacement. The ON block is a helpful alternative intervention, especially when the cost of intervention is a concern or when the total dose of BoNT-A exceeds the maximum dose recommended for multilevel injections.

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