



Investigation of interobserver reliability of the Gillette Functional Assessment Questionnaire in children with spastic diparetic cerebral palsy

Mintaze Kerem GÜNEL, Tülay TARSUSLU,* Akmer MUTLU, Ayşe LİVANELİOĞLU

Department of Physical Therapy and Rehabilitation, Faculty of Health Sciences, Hacettepe University, Ankara;

*School of Physical Therapy and Rehabilitation; İzzet Baysal University, Bolu

Objectives: Information obtained from families is of particular importance in the evaluation of functional mobility skills of children with cerebral palsy (CP) after orthopedic interventions and long-term rehabilitation applications. This study was designed to evaluate the interobserver reliability of the Gillette Functional Assessment Questionnaire (FAQ) which was administered to the mothers and the physiotherapist for children with CP.

Methods: The study included 52 spastic diparetic children with CP (22 girls, 30 boys; mean age 7.8±4.4 years; range 4 to 12 years) and their mothers. According to the Gross Motor Function Classification System (GMFCS), all the children were in level 1 to 3. The Gillette FAQ was administered to the mother and physiotherapist to determine the functional walking level of the child and the interobserver reliability of the FAQ was calculated. In addition, gross motor performance was evaluated by the standing and walking-running-jumping dimensions of the Gross Motor Performance Measure (GMPM), and functional independence level was evaluated by the transfer and locomotion dimensions of the Functional Independence Measure for Children (WeeFIM). Correlations were sought between the FAQ results of the physiotherapist and mothers and the GMFCS, GMPM, and WeeFIM.

Results: The intraclass correlation coefficient for interobserver reliability of the Gillette FAQ was 0.94 (95% CI 0.898-0.966). A highly significant correlation was found between the responses of the mother and physiotherapist to the Gillette FAQ ($r=0.882$, $p<0.01$). The responses of the mother and physiotherapist to the Gillette FAQ showed a negative correlation with the GMFCS level, and positive correlations with the dimensions of the GMPM and WeeFIM studied ($p<0.01$).

Conclusion: The Gillette FAQ can be used by the physiotherapists to determine the functional changes in spastic diparetic children with CP and can help clinicians derive important information from the families about functional walking of their children.

Key words: Cerebral palsy; child; disability evaluation; gait disorders, neurologic; observer variation; questionnaires.

Cerebral palsy (CP) can be defined as a developmental disorder related to the musculoskeletal system, caused by a lesion in the immature brain either in prenatal, natal or postnatal periods, in which main problems are movement, balance and posture disorders.

Besides disabilities of motor development, mental, visual, auditory, speech, and behavioral problems can also be seen. Functional disabilities caused by physical, cognitive, sensory, psychological, and social disturbances pose significant restraints for affected

children and their families to play their roles in the society.^[1,2]

Classification of CP on the basis of clinical findings encompasses five types, being spastic, dyskinetic, ataxic, hypotonic, and mixed.^[3] The majority of CP cases are spastic with a prevalence of about 70%. Diparetic children with CP, in whom the effect of spasticity is mainly seen in the lower extremities, have difficulty in performing reciprocal movements of crawling and walking. On standing, scissoring of lower extremities is observed. They have narrow step width and their feet have tendency for equinus and inversion. The muscles that spasticity affects most in diparetic cases are flexors, adductors and internal rotators of the hip, knee flexors, and plantar flexors, evertors/invertors of the ankle. This results in secondary weakness of the antagonists leading to contractures, deformities, and postural abnormalities. In the standing posture, a general extensor tone dominance is observed. Together with weakness of the hip abductors, an adaptive Trendelenburg gait pattern develops in the lower extremities. Hip flexor spasticity increases lordosis and tension of the quadriceps muscle, causing genu recurvatum. The most common ankle problems in spastic diparetic children are spastic equinus, pes varus, and pes valgus. Crouch gait is a common walking abnormality in these children.^[2,4,5]

Physical therapy applications in diparetic children focus on improving gait and posture deformities caused by spasticity, increasing their independence levels in daily activities and social participation, and increasing walking performance.^[6-8]

Children with CP should not only be assessed for motor skills (changes in muscle tone, co-contraction of the muscles, involuntary trunk and extremity movements, stabilization of extremities, reactions involving correction, balance and protection, sitting balance, upper extremity and hand functions, sense-perception problems), but also for their needs including orthosis, mobilization tools, and other supportive tools and devices, and for cooperation of the family and their level of knowledge on the disease.^[9]

There are various tools for the evaluation of motor level, functional development, and daily living activities including the Gross Motor Function Measure, Gross Motor Function Classification Sys-

tem (GMFCS), Pediatric Functional Independence Measure (WeeFIM) and, for measuring muscle tone, the Modified Ashworth Scale and Ashworth Scale.^[4,9-12]

In children with CP, evaluation of walking and functional independence level is frequently made to determine the effectiveness of treatment especially after use of orthosis, medical treatment, surgical procedures, and physiotherapy-rehabilitation applications. Observational methods of evaluation not only give significant information to rehabilitation practitioners but also are helpful and practical in eliciting information from family members and caregivers. One important advantage of observational methods of evaluation is that they provide information on functional walking.^[13-15]

Apart from clinical usage, gait analysis is used in studies on joint biomechanics with addition of pressure measurements to kinetic and kinematic measurements. A growing number of studies incorporate techniques of gait analysis in the evaluation of biomechanics of joints of the lower extremity, knee, hip, and ankle, and the mechanics of reconstructions performed in these joints. However, especially in developing countries, kinetic and kinematic analyses requiring computer systems and video camera measurements are not routinely available due to their complexity and expensiveness, making observational methods of evaluation and elicitation of information from families practical ways of walking assessment.^[16,17] Some examples of observational walking scales used in children with CP include the Gillette Functional Assessment Questionnaire (FAQ), Physician Rating Scale, and Functional Mobility Scale.^[13]

Considering the importance of information obtained from families in the evaluation of functional mobility skills after orthopedic interventions and long-term rehabilitation applications, this study was designed to evaluate the interobserver reliability of the Gillette FAQ which is frequently used in children with CP for clinical and scientific studies. To test the reliability of information obtained from parents, we assessed the consistency between the responses of the mother and the physiotherapist to the Gillette FAQ. We also aimed to introduce the functional walking ability scale to clinicians working in the field of pediatric rehabilitation.

Table 1
Gross Motor Function Classification System

| Level | Degree of function |
|-------|--|
| 1 | Walks without restrictions, but has some limitations in advanced gross motor skills. |
| 2 | Walks without an assistive mobility device, but has limitations walking in the community. |
| 3 | Walks with an assistive mobility device and has limitations walking in the community. |
| 4 | Self-mobility with limitations. Relies on wheeled mobility in the community. |
| 5 | Has no means of independent mobility, needs adaptive equipment and assistive technology, and is transported. |

Patients and methods

The study included 52 pediatric patients (22 girls, 30 boys; mean age 7.8±4.4 years; range 4 to 12 years) with spastic diparetic CP (GMFCS level 1-3), who were referred to the Department of Physical Therapy and Rehabilitation, Hacettepe University Faculty of Health Sciences, between February and October 2007. Patients younger than 4 years of age and those who received botulinum toxin or underwent orthopedic surgery within the past six months were excluded.

Written informed consent was obtained from the mothers. The study was approved by the Ethics Committee of Hacettepe University and was registered at Hacettepe University Scientific Research Unit with Project No. 03.02.401.002.

The Gross Motor Function Classification System is a five-level classification system used to classify gross motor functions of children with CP. It was developed by Palisano et al.^[18] in 1997. Gross motor function at each level is described in Table 1.

Methods of evaluation

The Gillette Functional Assessment Questionnaire (FAQ). It aims to elicit information from families and consists of 10 levels to evaluate functional walking (Table 2). Validity and reliability studies have shown that it reflects the degree of functional walking through information obtained from families in cases of chronic neurological disorders and musculo-skeletal disorders that affect walking.^[4] As the Turkish version of the Gillette FAQ was not available, the questionnaire was first translated into Turkish by the

authors through forward and backward translation. The final version of the questionnaire was approved and used in the study.

The Gross Motor Performance Measure (GMPM). It is a standardized observational evaluation measure and it measures the level of performance determined by gross motor ability in children with CP. It consists of 20 items derived from the Gross Motor Function Measure. Performance is rated based on alignment of body parts while making a movement, coordination,

Table 2
Gillette Functional Assessment Questionnaire: Functional Walking Scale*

Please choose the one answer below that best describes your child’s walking abilities. Choose only one answer.

- 1 Cannot take any steps at all.
- 2 Can do some stepping on his/her own with the help of another person. Does not take full weight on feet; does not walk on routine basis.
- 3 Walks for exercise in therapy and/or less than typical household distances.
- 4 Walks for household distances, but makes slow progress. Does not use walking at home as preferred mobility, but prefers to crawl or roll for speed or efficiency. (Walks for therapy or exercise)
- 5 Walks for household distances routinely at home and/or school. Indoor walking only.
- 6 Walks more than 15-50 feet outside the home but usually uses a wheelchair or stroller for community distances or in congested areas.
- 7 Walks outside for community distances, but only on level surfaces (cannot perform curbs, uneven terrain, or stairs without assistance of another person).
- 8 Walks outside the home for community distances, is able to get around on curbs and uneven terrain in addition to level surfaces, but usually requires minimal assistance or supervision for safety.
- 9 Walks outside the home for community distances, easily gets around on level ground, curbs, and uneven terrain, but has difficulty (or requires minimal assistance or supervision) with running climbing and/or stairs. Has some difficulty keeping up with peers.
- 10 Walks, runs, and climbs on level and uneven terrain and does stairs without difficulty or assistance. Is typically able to keep up with peers.

*Gillette Children’s Specialty Healthcare. Available from: <http://www.gillettechildrens.org/fileUpload/GFAQsurveypreview2.pdf>.

stability, weight shift, and dissociation. In our study, we used the two dynamic dimensions of the GMPM which are directly related to walking: standing and walking-running-jumping.^[19]

Functional Independence Measure (WeeFIM). It contains 18 items in six dimensions, being self-care, sphincter control, transfers, locomotion, communication, and social cognition. Every item in these dimensions is rated from 1 to 7 depending on whether the child needs aid while performing the function, whether it is done within normal time limits, or whether a supportive device is required. Completion of the task with full dependence on aid is rated as 1, while 7 is accorded to accomplished tasks performed in total independence, timely, and in safety. The overall score ranges from a minimum of 18 (totally dependent) to a maximum of 126 (totally independent). In our study, transfer and locomotion dimensions of the WeeFIM were used.^[20,21]

Evaluation of the children with the Gillette FAQ, GMPM, and WeeFIM was made by a physiotherapist (TT) having eight years of experience in the field of pediatric rehabilitation. Then, the Gillette FAQ was read to the mothers, elucidations were made where necessary, and their responses were recorded.

Statistical analysis

The mean and standard deviation (SD) for each test were calculated. The intraclass correlation coefficient (Cronbach's alpha) with 95% confidence intervals was calculated to determine interobserver reliability of the FAQ responses given by the mother and the physiotherapist. Inter-rater agreement was considered low, moderate, and high at coefficient values of <0.50, 0.50 to 0.75, and >0.75, respectively. Spearman's correlation analysis was used to assess the relationship between WeeFIM, GMPM, and the physiotherapist's and the mother's FAQ results. A *p* value of less than 0.05 was considered significant. All the statistical analyses were made using the SPSS software package for Windows (ver. 11.01).

Results

Demographic characteristics and Gillette FAQ, GMPM, and WeeFIM scores of the patients are presented in Table 3. According to the GMFCS, 10 patients (19.2%) were in level 1, 22 patients (42.3%) were in level 2, and 20 patients (38.5%) were in level 3. Distribution of Gillette FAQ, GMPM, and

WeeFIM scores according to the GMFCS levels is shown in Table 4.

A highly significant correlation was found between the responses of the mother and physiotherapist to the Gillette FAQ ($r=0.882$, $p<0.01$). The intraclass correlation coefficient for interobserver reliability was 0.94 (95% CI 0.898-0.966).

Both the responses of the mother and physiotherapist to the Gillette FAQ showed the following correlations with the three instruments of evaluation:

- Negative correlation with the GMFCS levels (mother, $r=-0.819$, $p<0.01$; physiotherapist, $r=-0.768$, $p<0.01$);
- Positive correlation with the GMPM: standing (mother, $r=0.612$, $p<0.01$; physiotherapist, $r=0.654$, $p<0.01$); walking-running-jumping (mother, $r=0.673$, $p<0.01$; physiotherapist, $r=0.730$, $p<0.01$);
- Positive correlation with the WeeFIM: transfer (mother, $r=0.554$, $p<0.01$; physiotherapist, $r=0.583$, $p<0.01$); locomotion (mother, $r=0.653$, $p<0.01$; physiotherapist, $r=0.67$, $p<0.01$).

Discussion

It is very difficult to evaluate functional walking ability of children with CP. Conventional gait analyses are not able to evaluate the functional dimension of

Table 3
Demographic characteristics and Gillette FAQ, GMPM, and WeeFIM scores of the patients

| | Mean±SD | Range |
|-------------------------|------------|--------|
| Height (cm) | 114.3±27.4 | 80-157 |
| Weight (kg) | 23.9±15.9 | 11-75 |
| Age (years) | 7.8±4.4 | 3-12 |
| Gillette FAQ | | |
| Physiotherapist | 6.0±2.9 | 2-10 |
| Mother | 6.2±2.8 | 2-10 |
| GMPM | | |
| Total | 153.3±49.9 | 42-240 |
| Standing | 31.3±17.1 | 0-60 |
| Walking-running-jumping | 27.2±14.8 | 6-60 |
| WeeFIM | | |
| Total | 91.2±25.5 | 49-126 |
| Transfer | 15.8±5.5 | 4-21 |
| Locomotion | 10.5±3.4 | 3-16 |

Gillette FAQ: Gillette Functional Assessment Questionnaire; GMPM: Gross Motor Performance Measure; WeeFIM: Functional Independence Measure.

Table 4
Gillette FAQ, GMPM, and WeeFIM scores according to the GMFCS levels

| GMFCS | n | % | Total WeeFIM | | Gillette FAG | | | | Total GMPM | |
|---------|----|------|--------------|---------|-----------------|-------|---------|-------|------------|---------|
| | | | Mean±SD | Range | Physiotherapist | | Mother | | Mean±SD | Range |
| | | | | | Mean±SD | Range | Mean±SD | Range | | |
| Level 1 | 10 | 19.2 | 120.5±7.0 | 102-126 | 8.9±1.2 | 7-10 | 9.0±0.8 | 8-10 | 197.4±35.4 | 150-240 |
| Level 2 | 22 | 42.3 | 93.2±22.8 | 60-126 | 6.9±1.7 | 3-9 | 7.4±1.3 | 5-9 | 165.8±36.8 | 72-212 |
| Level 3 | 20 | 38.5 | 74.2±19.4 | 49-112 | 4.0±1.6 | 2-7 | 3.8±1.7 | 2-8 | 117.5±45.0 | 42-191 |

GMFCS: Gross Motor Function Classification System; Gillette FAQ: Gillette Functional Assessment Questionnaire; GMPM: Gross Motor Performance Measure; WeeFIM: Functional Independence Measure.

walking, they mainly give information on angular and rotational dimensions of deformity and are not effective to determine the effect of deformity on activities of daily living.^[4]

Information derived from the family on daily functions of the patient is crucial both in the evaluation and as a guide to treatment.^[4] Information elicited from the family, especially from the mother, is frequently used after orthopedic interventions to record physical and functional improvements in children with developmental disabilities such as CP or myelomeningocele. Thus, expectations of both the child and the family are determined. Since mothers are an important part of the rehabilitation team, we aimed to determine how reliable information they gave on the functional skills of their children when evaluating their children and giving feedback to their physiotherapists. For this purpose, we used the Gillette FAQ, which rates functional walking capacity from 0 to 10 points in spastic diparetic children with CP.

Daltroy et al.^[22] showed that families having children with chronic and progressive disabilities provided valid and reliable information on functional mobility and walking level of their children in the community. Likewise, Furlong et al.^[14] reported that administration of the Gillette FAQ to patients' families was quite reasonable. In our study, the intraclass correlation coefficient of the Gillette FAQ for mother-physiotherapist reliability was 0.94. In addition, responses of the mothers and the physiotherapist to the Gillette FAQ were highly correlated. The high level of statistical agreement between the information derived from the mothers and the comment of the physiotherapist suggests that the Gillette FAQ can be used as a reliable instrument when evaluating functional walking in rehabilitation applications.

In functional walking, advanced motor functions of the child such as running, jumping, and walking up and down stairs are also important.^[4] In our study, standing and walking-running-jumping parameters of the GMPM were highly correlated with both the responses of the mother and physiotherapist to the Gillette FAQ. Viehweger et al.^[23] found that unstable standing posture and walking and low level of functional skills were associated with a high level of motor activation in children with CP. Several other studies reported a significantly high correlation between the Gillette FAQ and motor functions like standing, running, and jumping.^[11,9,10] The finding of a significant correlation between the mother's and physiotherapist's responses to the Gillette FAQ suggests that families can offer quite reasonable evaluations about their children.

In our study, the GMFCS was inversely correlated with the responses of the mother and physiotherapist to the Gillette FAQ. This finding was also reported by other studies.^[24,25] Amichai et al.^[25] stated that the presence of an inverse association between the Gillette FAQ and GMFCS was within expectations, in that better walking skills were related to the gross motor function level and low energy expenditure level, the latter being related to the functional level. The Gross Motor Function Classification System rates the motor function at five levels from 1 (best) to 5 (weakest). Our finding of a strong negative correlation between the Gillette FAQ and GMFCS implies that the Gillette FAQ is effective in the differentiation of motor levels.

We also evaluated the relationship between the Gillette FAQ and the transfer and locomotion parameters of the WeeFIM that are thought to be directly related with the walking function. A strong correla-

tion was found between the responses of the mother and physiotherapist to the Gillette FAQ and the transfer and locomotion dimensions of the WeeFIM. This relationship was also reported in other studies.^[4,9,13] Tervo et al.^[26] indicated that the Gillette FAQ was good at evaluating the functional changes and ambulation level in children with CP, was effective in determining their mobility in the community, and showed a high correlation with upper extremity function, transfer, and mobility.

The study by Novacheck et al.^[4] on the validity and reliability of the Gillette FAQ seems to be the most important study supporting our work in the literature. In children with chronic disabilities, they found a high interobserver reliability (Cronbach's alpha 0.92) for information obtained from families and clinicians. In our study, the Cronbach's alpha value was even higher (0.94). In addition, the statistically significant associations with the GMFCS, transfer and locomotion dimensions of the WeeFIM, and standing and walking-running-jumping dimensions of the GMPM show that the Gillette FAQ is highly compatible with functionality and motor performance levels.

Evaluation of the functional walking performance affecting daily activities of children with CP has become increasingly important in recent years both for the effectiveness of, and as a guide to, rehabilitation applications. Hence, there is a need for evaluation methods that have proven validity and reliability and accuracy of measuring function, reflect family feedback effectively, and include expectations of both patients and families. In this regard, with participation of the family, the Gillette FAQ is a reliable questionnaire that can be used to evaluate the child's functions in daily life, assess the effectiveness of treatment following long-term rehabilitation applications and orthopedic interventions, and determine changes in functional walking.

The small number of cases and inclusion of only spastic diparetic CP patients may be mentioned as the main limitations of our study. Further studies with inclusion of diverse disability groups and large patient populations are necessary.

References

1. Pirpiris M, Gates PE, McCarthy JJ, D'Astous J, Tylkowski C, Sanders JO, et al. Function and well-being in ambulatory children with cerebral palsy. *J Pediatr Orthop* 2006;26:119-24.
2. Damiano DL, Laws E, Carmines DV, Abel MF. Relationship of spasticity to knee angular velocity and motion during gait in cerebral palsy. *Gait Posture* 2006;23:1-8.
3. Hagberg B, Hagberg G, Olow I. The changing panorama of cerebral palsy in Sweden 1954-1970. I. Analysis of the general changes. *Acta Paediatr Scand* 1975;64:187-92.
4. Novacheck TF, Stout JL, Tervo R. Reliability and validity of the Gillette Functional Assessment Questionnaire as an outcome measure in children with walking disabilities. *J Pediatr Orthop* 2000;20:75-81.
5. Cardoso ES, Rodrigues BM, Barroso M, Menezes CJ, Lucena RS, Nora DB, et al. Botulinum toxin type A for the treatment of the spastic equinus foot in cerebral palsy. *Pediatr Neurol* 2006;34:106-9.
6. Kerem M, Livanelioğlu A, Topçu M. Effects of Johnstone pressure splints combined with neurodevelopmental therapy on spasticity and cutaneous sensory inputs in spastic cerebral palsy. *Dev Med Child Neurol* 2001; 43:307-13.
7. Kerem-Günel M. Rehabilitation of children with cerebral palsy from a physiotherapist's perspective. [Article in Turkish] *Acta Orthop Traumatol Turc* 2009;43:173-80.
8. Mutlu A, Krosschell K, Spira DG. Treadmill training with partial body-weight support in children with cerebral palsy: a systematic review. *Dev Med Child Neurol* 2009;51:268-75.
9. Sullivan E, Barnes D, Linton JL, Calmes J, Damiano D, Oeffinger D, et al. Relationships among functional outcome measures used for assessing children with ambulatory CP. *Dev Med Child Neurol* 2007;49:338-44.
10. Oeffinger D, Gorton G, Bagley A, Nicholson D, Barnes D, Calmes J, et al. Outcome assessments in children with cerebral palsy, part I: descriptive characteristics of GMFCS Levels I to III. *Dev Med Child Neurol* 2007;49:172-80.
11. Mutlu A, Livanelioğlu A, Günel MK. Reliability of Ashworth and Modified Ashworth scales in children with spastic cerebral palsy. *BMC Musculoskelet Disord* 2008; 9:44.
12. Günel MK, Mutlu A, Tarsuslu T, Livanelioğlu A. Relationship among the Manual Ability Classification System (MACS), the Gross Motor Function Classification System (GMFCS), and the functional status (WeeFIM) in children with spastic cerebral palsy. *Eur J Pediatr* 2009; 168:477-85.
13. Harvey A, Robin J, Morris ME, Graham HK, Baker R. A systematic review of measures of activity limitation for children with cerebral palsy. *Dev Med Child Neurol* 2008; 50:190-8.
14. Furlong W, Barr RD, Feeny D, Yandow S. Patient-focused measures of functional health status and health-related quality of life in pediatric orthopedics: a case study in measurement selection. *Health Qual Life Outcomes* 2005;3:3.
15. Schwartz MH, Rozumalski A. The Gait Deviation Index:

- a new comprehensive index of gait pathology. *Gait Posture* 2008;28:351-7.
16. Corry IS, Cosgrove AP, Duffy CM, McNeill S, Taylor TC, Graham HK. Botulinum toxin A compared with stretching casts in the treatment of spastic equinus: a randomised prospective trial. *J Pediatr Orthop* 1998;18:304-11.
 17. Maathuis KG, van der Schans CP, van Iperen A, Rietman HS, Geertzen JH. Gait in children with cerebral palsy: observer reliability of Physician Rating Scale and Edinburgh Visual Gait Analysis Interval Testing scale. *J Pediatr Orthop* 2005;25:268-72.
 18. Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. *Dev Med Child Neurol* 1997;39:214-23.
 19. Boyce WF, Gowland C, Rosenbaum PL, Lane M, Plews N, Goldsmith CH, et al. The Gross Motor Performance Measure: validity and responsiveness of a measure of quality of movement. *Phys Ther* 1995;75:603-13.
 20. Aybay C, Erkin G, Elhan AH, Sirzai H, Özel S. ADL assessment of nondisabled Turkish children with the WeeFIM instrument. *Am J Phys Med Rehabil* 2007;86:176-82.
 21. Ottenbacher KJ, Msall ME, Lyon NR, Duffy LC, Granger CV, Braun S. Interrater agreement and stability of the Functional Independence Measure for Children (WeeFIM): use in children with developmental disabilities. *Arch Phys Med Rehabil* 1997;78:1309-15.
 22. Daltroy LH, Liang MH, Fossel AH, Goldberg MJ. The POSNA pediatric musculoskeletal functional health questionnaire: report on reliability, validity, and sensitivity to change. Pediatric Outcomes Instrument Development Group. Pediatric Orthopaedic Society of North America. *J Pediatr Orthop* 1998;18:561-71.
 23. Viehweger E, Haumont T, de Lattre C, Presedo A, Filipetti P, Ilharreborde B, et al. Multidimensional outcome assessment in cerebral palsy: is it feasible and relevant? *J Pediatr Orthop* 2008;28:576-83.
 24. Trost JP, Schwartz MH, Krach LE, Dunn ME, Novacheck TF. Comprehensive short-term outcome assessment of selective dorsal rhizotomy. *Dev Med Child Neurol* 2008;50:765-71.
 25. Amichai T, Harries N, Dvir Z, Patish H, Copeliovitch L. The effects of femoral derotation osteotomy in children with cerebral palsy: an evaluation using energy cost and functional mobility. *J Pediatr Orthop* 2009;29:68-72.
 26. Tervo RC, Azuma S, Stout J, Novacheck T. Correlation between physical functioning and gait measures in children with cerebral palsy. *Dev Med Child Neurol* 2002;44:185-90.