Postural deformity in children with cerebral palsy: Why it occurs and how is it managed

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ABSTRACT. Despite the fact that children with cerebral palsy may not have any deformities at the time of birth, postural deformities, such as scoliosis, pelvic obliquity, and windswept hip deformity, can appear with increasing age. This may lead to respiratory function deterioration and, in more severe cases, affects survival. To date, postural care is believed to help improve the health and quality of life of children with cerebral palsy. This review provides an overview of the cause and clinical management of postural deformity that is seen in children with cerebral palsy.

Key words: Scoliosis, windswept hip deformity, pelvic obliquity, hip dislocation

Cerebral palsy (CP) does not refer to a specific disease but is an umbrella term that refers to a group of disorders affecting a person’s ability to move that occurs in the developing fetal or infant brain. Despite the fact that the musculoskeletal status of children with CP is usually normal at birth, postural deformities can progressively arise with development. Postural deformity has a significant impact on not only the quality of life in children with CP, but also on their mortality. Severe scoliosis and deformed chest cage lead to lung compression. Respiratory problems are frequent among patients with CP and are a significant cause of death. These secondary problems, which can lead to functional decline, should be avoided. Various studies have been conducted to investigate the cause of the deformities and how to prevent them; however, there are still unknowns. This review provides an overview of the cause and the clinical management of postural deformities that are seen in children with CP.

Postural Deformity in Children with CP

Posture in this review will refer mainly to a sitting or lying position. Deformity refers to an abnormality of the position of the body compared to a normal position. Children with CP tend to show a specific pattern of deformity, a so-called “postural deformity” or “positional deformity”. This review uses the term “postural deformity” that includes the following deformities: scoliosis, pelvic obliquity, windswept hip deformity, and hip subluxation/dislocation. A typical image of the postural deformity seen in children with CP is illustrated in Fig. 1. The head is turned to one side, and there is a marked pelvic tilt with spinal scoliosis. Windswept hip deformity is also seen, where one leg falls into abduction and external rotation, and the opposite leg into adduction and internal rotation. Such deformations can cause difficulties in the daily activities of children with CP, such as that in maintaining a sitting position and/or rolling over on a mat. Moreover, postural deformity accompanied with deformed chest cage can decrease respiratory function. In CP, recurrent aspiration and impaired airway clearance due to respiratory muscle weakness and/or poor coordination, combined with spinal and thorax deformities, can lead to both acute respiratory tract infections as well as chronic lower airway inflammation, ultimately resulting in bronchiectasis. Once bronchiectasis occurs, this further impairs clearance of sputa, resulting in repeated bronchitis. Respiratory disease is the most significant factor in the causal pathway of CP-related mortality. Knee flexion contracture and equinovarus foot are also...
common deformities noted in CP, but these affect more functional aspects such as gait. Since postural deformity affects respiratory function and indirectly affects mortality, more attention must be paid to this than to other deformities.

Change in Postural Deformity with Age

Generally, no structural abnormality is apparent in the trunk or extremities at the time of birth. However, problems arise in the course of postnatal development, and postural deformities gradually become more prominent (Fig. 2). In severe cases, the deformities continuously progress beyond the growth period.

Among the postural deformity types, hip dislocation is likely to be detected early in childhood. Hip dislocation in CP often appears at 2-3 years of age. Scoliosis appears at 5-6 years of age in children with severe CP, and at around 8 years of age in children with mild CP. Windswept hip deformity becomes prominent by the age of 10 years, and the risk of deformity continues thereafter.

Relationship between Postural Deformity and Gross Motor Function

The clinical features of children with CP vary. Classifications of CP have focused on types of tone abnormalities such as spasticity, athetosis, and dystonia; however, the classifications do not provide prognostic information. Gross motor function classification system for CP (GMFCS) is a useful tool to predict limits of motor function for a given level of CP severity. It divides children with CP into five groups based on the overall functional capability (Table 1): no functional impairment; functional limitation when walking in crowds, may need assistive device; walks with an assistive device; and cannot sit independently, bedridden. Gross motor development curves, which correspond to each of the 5 GMFCS levels of severity, are widely recognized. Once a child is assigned to a GMFCS level, the corresponding motor function change curve shows the average pattern of change in the motor score. The majority of children with CP reach a peak motor function score at 5-7 years of age. Patterns of gross motor development by level of severity have been explained by a stable limit model (SLM) or a peak and decline model (PDM) (Fig. 3). Children at GMFCS level 1 and 2 have no functional decline, thus the SLM was embraced. In contrast, at level 3, 4, and 5, they show significant decline after a peak at 7 years of age; thus, the PDM was embraced. As mentioned above, trunk deformity becomes noticeable around 7 years of age, but it is thought that deformation may also be involved in such functional decline.

The gross motor function of children with CP is closely related to the occurrence of postural deformity, and more severe deformity is observed in individuals with higher GMFCS levels. Persson-Bunke et al. found that the proportion of children with scoliosis increased with GMFCS level and that those with GMFCS level 4 and 5 had a 50% risk of having moderate or severe scoliosis by the age of 18 years. Haglund et al. reported that 75% of children had severe scoliosis with a Cobb angle of 40 degrees or greater at the age of 20 years. No child developed hip dislocations with migration percentage exceeding 40% in GMFCS level 1, while 10% of children with level 2,
Abnormalities in muscle tone and/or muscle imbalance have been established as the primary cause of postural deformity in children with CP. Typically, hip dislocation is explained by the muscular imbalance in which strong hip flexors and adductors overpower the hip extensors and abductors. However, asymmetrical muscle activity does not clearly explain the patterns of deformity. For example, if the right side of the spinal muscle contracts more to the left side, the spine bends to the right. However, no relationship between the direction of dominant muscle tone and the direction of scoliosis has been established. Moreover, Porter et al. found that a particular asymmetrical recumbent posture in the first year of life was associated with the direction of the subsequent pattern of postural deformity. Therefore, postural deformity may start as the simple tendency of an individual to spend a lot of time in a particular asymmetrical position.

Environmental factors, such as remaining in asymmetrical recumbent postures for prolonged periods due to poor ability of a child to move spontaneously, should be considered. Children with severe CP tend to remain in the same body configuration for extended periods when sleeping. Several systems have been developed to monitor posture in the daily life of children with CP, by determining the angular orientation with respect to gravity of the body part to which an accelerometer is attached. With this method, body posture can be monitored at all times, in the midst of both daily and nocturnal activities in the life of a child with CP (Fig. 4). As a risk factor for emergence and progression of postural deformity, an abnormal muscle tone, in addition to prolonged asymmetric posture, should be considered.

### How We Care the Postural Deformity

**Spasticity reducing:** Reducing spasticity seems to be the most direct treatment for improving or preventing deformities but has no effect in the long term. For example, intramuscular injections of botulinum toxin A can be effective in reducing muscle tone over a long period, but does not prevent development of contractures in spastic muscles. The results of an 11-year follow-up study indicated that hip dislocation in children with CP is related to the severity of motor function classification, rather than the

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**Table 1.** Summary of the Gross Motor Classification System (GMFCS) for children with cerebral palsy developed by Palisano et al. 1998

| GMFCS level | Description |
|-------------|-------------|
| Level I     | Walks without limitation; performs running and jumping; but speed, balance, and coordination are reduced. |
| Level II    | Walks without assistive devices; limitations in walking outdoors and in the community. |
| Level III   | Walks with handheld assistive devices; limitations in walking outdoors and in the community. |
| Level IV    | Children can sit but are usually supported; more reliance on wheeled mobility in the community. |
| Level V     | Lack of independence even in basic antigravity postural control; self-mobility is severely limited, even with the use of assistive technology. |

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Figure 3. Gross motor development curves explained by the stable limit model and the peak and decline model. The stable limit model was embraced for children with mild CP; in contrast, the peak and decline model was embraced for children with severe CP. 7 years was the average age that peak of motor development was reached. (adapted with permission from Hanna SE, Rosenbaum PL, et al.: Stability and decline in gross motor function among children and youth with cerebral palsy aged 2 to 21 years. Dev Med Child Neurol. 2009; 51: 295-302)
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Figure 4. Example of body posture during night-time sleep in a child with typical development (TD: 7 years) and a child with severe cerebral palsy (CP: 8 years) (unpublished data). Note that the prolonged period spent in the WP position was observed in CP. WP: windswept hip position.

definition of whether the muscle tone is spastic, dystonic, or mixed. Moreover, several studies demonstrated a significant increase in the rate of scoliotic curve progression after spasticity-reducing treatment. One possible reason for this is that the loss of muscle tone leads to difficulty in maintaining or changing posture, which causes development and/or progression of deformity.

Surgery: Postural deformity mostly occurs in children with severe CP (GMFCS level 4 and 5), and the degree of the deformity is also more severe in these children. Risk of complications is high, and thus, the indications for surgery should be carefully discussed. One major type of surgery for deformity is spinal fusion for scoliosis. The expected effects of the surgery include the arrest of the deformity progression, avoidance of cardiopulmonary dysfunction, improvement of posture, and ease of care. However, the effects actually obtained are mainly related to functional aspects, such as improved posture and a reduction in the need for sitting supports, and the evidence of the effect is equivocal for arrest of deformity and improvement of cardiopulmonary function.

Passive stretching: Passive stretching is performed with the aim of preventing a decrease in the range of joint motion due to a decrease of muscle extensibility. Although passive stretching may lead to a temporary improvement in passive range, there is lack of evidence supporting that it can prevent a decreased range of motion i.e. contracture.

An interesting study conducted by Tardieu et al., investigated how many times a muscle should be stretched for preventing contractures in children with CP. They recorded the range of ankle joint motion continuously for a 24 hour period using their own apparatus. After mean duration of 7 months, they compared the total stretch time between children with CP who showed progressive contracture and those who did not. All children without progressive contracture showed a minimum of 6 hours’ stretch time during a 24-hour period. In contrast, all children with progressive contracture showed a shorter stretch time of approximately 0 to 3 hours. This indicates that even if a therapist can maintain a child’s muscle in the stretched position manually, he or she should maintain it more than 6 hours a day. Wearing a night-time splint may be reasonable to keep the soleus muscle stretched. However, it was shown that a child failed to keep the soleus muscle stretched despite wearing a night-time splint. The child also developed contractures, indicating that a splint is useless if not properly worn.

This implies that the duration of stretching, whether it is done passively or actively, may be the key to prevent contracture. However, during passive stretching, the child is literally in a passive state, exerts very less effort, and tends to get bored. They would experience a much longer period of stretching from self-motivated activities, such as going to school, horseback riding, and swimming programs, that in turn lead to long-lasting effects of stretching.
Bracing: Spinal bracing does not influence the natural course of scoliosis progression\(^{63,64}\). Rather, it is effective in improving stability in sitting, which results in better overall function\(^{63,64}\). One reason for bracing not being able to prevent scoliosis progression might be that children with CP do not use the orthosis long enough, especially during the night\(^{64}\). Children with severe CP tend to spend more time in a lying position, which might limit the bracing time. Spinal orthoses may be more suitable for use by children with mild CP who focus on increasing sitting stability, which promotes upper limb use instead of preventing deformity.

Postural care: An expert multidisciplinary group developed a consensus statement on postural management of children with CP based on evidence from clinical experience and scientific literature\(^{45}\). In the consensus statement, a 24-hour posture management program is recommended for children with severe CP (GMFCS level 4 and 5) that focuses on the role in preventing deformities\(^{65,66}\). One example of the postural management is the use of night-time postural equipment\(^{67,68}\). This consisted of supportive mattresses and padded supports, which promote a symmetric anatomically-correct lying position\(^{67,69}\). Some studies show that postural care may be effective in preventing hip dislocation\(^{63,67,70}\); however, evidence regarding the efficacy of postural care is still lacking\(^{71}\).

Cerebral Palsy Follow-Up Program: A surveillance program for CP called the Cerebral Palsy Follow-Up Program (CPUP) was established in 1994 in southern Sweden\(^{22}\). This hip surveillance method includes a standardized follow-up of gross and fine motor function, clinical findings, and treatment\(^{22}\). The gross and fine motor function of a child is examined by a local physical therapist and occupational therapist twice a year until the age of 6 years, and once a year thereafter\(^{22}\). The survey involves a standardized radiographic screening of the hip even in children with no symptoms\(^{23}\). The radiographic examination is conducted once a year for children in GMFCS levels 3 to 5, and at 2 and 6 years of age in those with level 2\(^{22}\). Those with level 1 are not examined\(^{23}\). This follow-up program aims for early detection of contractures and deformities that will then allow for early, preferably non-surgical, treatment\(^{22}\).

After the CPUP program was started, the incidence of hip dislocation and wind-swept hip deformities in children with CP was reduced\(^{22,23}\). An early detection of deformities would be necessary for postural management for those children.

Conclusion

Postural deformity exhibiting complex aspects, such as scoliosis, wind-swept hip deformity, pelvic obliquity, and hip dislocation, is frequently seen in children with severe cerebral palsy, who can hardly move by themselves. This deformity affects the prognosis of such children. The author believes that the key to preventing postural deformity is to detect it at an early stage and to apply postural care for the at-risk children.

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References

1) Bax M, Goldstein M, et al.: Proposed definition and classification of cerebral palsy. April 2005. Dev Med Child Neurol. 2005; 47: 571-576.
2) Rosenbaum P, Paneth N, et al.: A report: the definition and classification of cerebral palsy. April 2006. Dev Med Child Neurol Suppl. 2007; 109: 8-14.
3) Gudjonsdottir B and Mercer VS: Hip and spine in children with cerebral palsy: musculoskeletal development and clinical implications. Pediatr Phys Ther. 1997; 9: 179-185.
4) Huser A, Mo M, et al.: Hip surveillance in children with cerebral palsy. Orthop Clin North Am. 2018; 49: 181-190.
5) Lee SY, Chung CY, et al.: Annual changes in radiographic indices of the spine in cerebral palsy patients. Eur Spine J. 2016; 25: 679-686.
6) Scrutton D, Baird G, et al.: Hip dysplasia in bilateral cerebral palsy: incidence and natural history in children aged 18 months to 5 years. Dev Med Child Neurol. 2001; 43: 586-600.
7) Mercado E, Alman B, et al.: Does spinal fusion influence quality of life in neuromuscular scoliosis? Spine (Phila Pa 1976). 2007; 32: S120-125.
8) Boel L, Pernet K, et al.: Respiratory morbidity in children with cerebral palsy: an overview. Dev Med Child Neurol. 2019; 61: 646-653.
9) Ito K, Kawakami N, et al.: Scoliosis associated with airflow obstruction due to endothoracic vertebral hump. Spine (Phila Pa 1976). 2012; 37: 2094-2098.
10) Keskinen H, Lukkarinen H, et al.: The lifetime risk of pneumonia in patients with neuromuscular scoliosis at a mean age of 21 years: the role of spinal deformity surgery. J Child Orthop. 2015; 9: 357-364.
11) Seddon PC and Khan Y: Respiratory problems in children with neurological impairment. Arch Dis Child. 2003; 88: 75-78.
12) Cloake T and Gardner A: The management of scoliosis in children with cerebral palsy: a review. Journal of spine surgery (Hong Kong). 2016; 2: 299-309.
13) Imrie MN and Yaszay B: Management of spinal deformity in cerebral palsy. Orthop Clin North Am. 2010; 41: 531-547.
14) Perez-de la Cruz S: Cerebral palsy and the use of positioning systems to control body posture: current practices. Neurologia (Barcelona, Spain). 2017; 32: 610-615.
15) Robertson J, Baines S, et al.: Postural care for people with intellectual disabilities and severely impaired motor function: A
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scoping review. J Appl Res Intell Disabil. 2018; 31: 11-28.
16) Porter D, Michael S, et al.: Patterns of postural deformity in non-ambulant people with cerebral palsy: what is the relationship between the direction of scoliosis, direction of pelvic obliquity, direction of windswept hip deformity and side of hip dislocation? Clin Rehabil. 2007; 21: 1087-1096.
17) Brown K: Positional deformity in children with cerebral palsy. Physiother Theory Pract. 1985; 1: 37-41.
18) Rodby-Bousquet E, Czuba T, et al.: Postural asymmetries in young adults with cerebral palsy. Dev Med Child Neurol. 2013; 55: 1009-1015.
19) L Jr H: Pediatric cerebral palsy life expectancy: has survival improved over time? Pediatr Ther. 2013; 3.
20) Chan G and Miller F: Assessment and treatment of children with cerebral palsy. Dev Med Child Neurol. 1997; 39: 214-223.
21) Porter D, Michael S, et al.: Is there a relationship between preferred posture and positioning in early life and the direction of subsequent asymmetrical postural deformity in non ambulant people with cerebral palsy? Child Care Health Dev. 2008; 34: 635-641.
22) Hagglund G, Lauge-Pedersen H, et al.: Windswept hip deformity in children with cerebral palsy: a population-based prospective follow-up. J Child Orthop. 2016; 10: 275-279.
23) Holmes C, Brock K, et al.: Postural asymmetry in non-ambulant adults with cerebral palsy: a scoping review. Disabil Rehabil. 2019; 41: 1079-1088.
24) Majd ME, Muldowny DS, et al.: Natural history of scoliosis in the institutionalized adult cerebral palsy population. Spine. 1997; 22: 1461-1466.
25) Oda Y, Takigawa T, et al.: Scoliosis in Patients with Severe Cerebral Palsy: Three Different Courses in Adolescents. Acta Med Okayama. 2017; 71: 119-126.
26) Saito N, Ebara S, et al.: Natural history of scoliosis in spastic cerebral palsy. Lancet. 1998; 351: 1687-1692.
27) Hagglund G, Lauge-Pedersen H, et al.: Characteristics of children with hip displacement in cerebral palsy. BMC Musculoskelet Disord. 2007; 8: 101.
28) Hagglund G, Pettersson K, et al.: Incidence of scoliosis in cerebral palsy. Acta Orthop. 2018; 89: 443-447.
29) Yoshida K, Kajiura I, et al.: Natural history of scoliosis in cerebral palsy and risk factors for progression of scoliosis. J Orthop Sci. 2018; 23: 649-652.
30) Persson-Bunke M, Hagglund G, et al.: Scoliosis in a total population of children with cerebral palsy. Spine (Phila Pa 1976). 2012; 37: E708-713.
31) Kinsman SL: Predicting gross motor function in cerebral palsy. JAMA. 2002; 288: 1399-1400.
32) Palisano R, Rosenbaum P, et al.: Development and reliability of a system to classify gross motor function in children with cerebral palsy. Dev Med Child Neurol. 1997; 39: 214-223.
33) Rosenbaum PL, Walter SD, et al.: Prognosis for gross motor function in cerebral palsy creation of motor development curves. JAMA. 2002; 288: 1357-1363.
34) Palisano RJ, Hanna SE, et al.: Validation of a model of gross motor function for children with cerebral palsy. Phys Ther. 2000; 80: 974-985.
35) Beckung E, Carlsson G, et al.: The natural history of gross motor development in children with cerebral palsy aged 1 to 15 years. Dev Med Child Neurol. 2007; 49: 751-756.
36) Hanna SE, Bartlett DJ, et al.: Reference Curves for the Gross Motor Function Measure: Percentiles for clinical description and tracking over time among children with cerebral palsy. Phys Ther. 2008; 88: 596-607.
37) Hanna SE, Rosenbaum PL, et al.: Stability and decline in gross motor function among children and youth with cerebral palsy aged 2 to 21 years. Dev Med Child Neurol. 2009; 51: 295-302.
38) Smits DW, Gorter JW, et al.: Longitudinal development of gross motor function among Dutch children and young adults with cerebral palsy: an investigation of motor growth curves. Dev Med Child Neurol. 2013; 55: 378-384.
39) Madigan RR and Wallace SL: Scoliosis in the institutionalized cerebral palsy population. Spine. 1981; 6: 583-590.
40) Dohin B: The spastic hip in children and adolescents. Orthop Traumatol Surg Res. 2019; 105: S133-S141.
41) Young NL, Wright JG, et al.: Windswept hip deformity in spastic quadriplegic cerebral palsy. Pediatr Phys Ther. 1998; 10: 94-100.
42) Goldsmith J and Goldsmith L: Physical management. In: Lacey P and Ouvry C (eds): People with profound and multiple learning disability: a collaborative approach to meeting complex needs, David Fulton Publishers, London, UK, 1998, pp. 15-28.
43) Scrutton D: Position as a cause of deformity in children with cerebral palsy (1976). Dev Med Child Neurol. 2008; 50: 404.
44) Ägústsson A, Sveinsson T, et al.: Preferred posture in lying and its association with scoliosis and windswept hips in adults with cerebral palsy. Disabil Rehabil. 2018; 41: 3198-3202.
45) Sato H, Iwasaki T, et al.: Monitoring of body position and motion in children with severe cerebral palsy for 24 hours. Disabil Rehabil. 2014; 36: 1156-1160.
46) Sato H and Hirai T: A preliminary study describing body position in daily life in children with severe cerebral palsy using a wearable device. Disabil Rehabil. 2011; 33: 2529-2534.
47) Sato H, Ikura D, et al.: Assessing head and trunk symmetry during sleep using tri-axial accelerometers. Disabil Rehabil Assist Technol. 2015; 10: 113-117.
48) Ginsburg GM and Lander AJ: Progression of scoliosis in patients with spastic quadriplegia after the insertion of an intrathecal baclofen pump. Spine. 2007; 32: 2745-2750.
49) Golan JD, Hall JA, et al.: Spinal deformities following selective dorsal rhizotomy. J Neurosurg Pediatr. 2007; 106: 441-449.
50) Senaran H, Shah SA, et al.: The risk of progression of scoliosis in cerebral palsy patients after intrathecal baclofen therapy. Spine (Phila Pa 1976). 2007; 32: 2348-2354.
51) Shilt JS, Lai LP, et al.: The impact of intrathecal baclofen on the natural history of scoliosis in cerebral palsy. J Pediatr Orthop. 2008; 28: 684-687.
52) Tedroff K, Granath F, et al.: Long-term effects of botulinum toxin A in children with cerebral palsy. Dev Med Child Neurol. 2008; 50: 532-537.
53) Tedroff K, Lowing K, et al.: Does loss of spasticity matter? A 10-year follow-up after selective dorsal rhizotomy in cerebral palsy. Dev Med Child Neurol. 2011; 53: 724-729.

54) Walker KR, Novotny SA, et al.: Does Intrathecal baclofen therapy increase prevalence and/or progression of neuromuscular scoliosis? Spine Deform. 2017; 5: 424-429.

55) Soo B, Howard JJ, et al.: Hip displacement in cerebral palsy. J Bone Joint Surg Am. 2006; 88: 121-129.

56) Whitaker AT, Sharkey M, et al.: Spinal fusion for scoliosis in patients with globally involved cerebral palsy: an ethical assessment. J Bone Joint Surg Am. 2015; 97: 782-787.

57) Adams AJ, Refakis CA, et al.: Surgeon and caregiver agreement on the goals and indications for scoliosis surgery in children with cerebral palsy. Spine Deform. 2019; 7: 304-311.

58) Sewell MD, Wallace C, et al.: Does spinal fusion and scoliosis correction improve activity and participation for children with GMFCS level 4 and 5 cerebral palsy? Medicine (Baltimore). 2015; 94: e1907.

59) Gough M: Continuous postural management and the prevention of deformity in children with cerebral palsy: an appraisal. Dev Med Child Neurol. 2009; 51: 105-110.

60) Pin T, Dyke P, et al.: The effectiveness of passive stretching in children with cerebral palsy. Dev Med Child Neurol. 2006; 48: 855-862.

61) Tardieu C, Lespargot A, et al.: For how long must the soleus muscle be stretched each day to prevent contracture? Dev Med Child Neurol. 1988; 30: 3-10.

62) Wiart L, Darrah J, et al.: Stretching with children with cerebral palsy: what do we know and where are we going? Pediatr Phys Ther. 2008; 20: 173-178.

63) Pettersson K and Rodby-Bousquet E: Prevalence and goal attainment with spinal orthoses for children with cerebral palsy. J Pediatr Rehabil Med. 2019; 12: 197-203.

64) Terjesen T, Lange JE, et al.: Treatment of scoliosis with spinal bracing in quadriplegic cerebral palsy. Dev Med Child Neurol. 2000; 42: 448-454.

65) Gericke T: Postural management for children with cerebral palsy: consensus statement. Dev Med Child Neurol. 2006; 48: 244.

66) Gough M: Continuous postural management and the prevention of deformity in children with cerebral palsy: an appraisal. Dev Med Child Neurol. 2009; 51: 105-110.

67) Goldsmith S: The mansfield project: postural care at night within a community setting: a feedback study. Physiotherapy. 2000; 86: 528-534.

68) Hill CM, Parker RC, et al.: Sleep quality and respiratory function in children with severe cerebral palsy using night-time postural equipment: a pilot study. Acta Paediatr. 2009; 98: 1809-1814.

69) Pountney T, Mandy A, et al.: Management of hip dislocation with postural management. Child Care Health Dev. 2002; 28: 179-185.

70) Hankinson J and Morton RE: Use of a lying hip abduction system in children with bilateral cerebral palsy: A pilot study. Dev Med Child Neurol. 2002; 44: 177.

71) Picciolini O, Le Metayer M, et al.: Can we prevent hip dislocation in children with cerebral palsy? Effects of postural management. Eur J Phys Rehabil Med. 2016; 52: 682-690.

72) Hagglund G, Alriksson-Schmidt A, et al.: Prevention of dislocation of the hip in children with cerebral palsy: 20-year results of a population-based prevention programme. Bone Joint J. 2014; 96-B: 1546-1552.