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Interventions and Management

1. J Child Orthop. 2014 Nov 28. [Epub ahead of print]

Comparison of hamstring transfer with hamstring lengthening in ambulatory children with cerebral palsy: further follow-up.

De Mattos C1, Patrick Do K, Pierce R, Feng J, Aiona M, Sussman M.

BACKGROUND: Overactivity or contractures of the hamstring muscles in ambulatory children with cerebral palsy (CP) can lead to either a jump gait (knee flexion associated with ankle plantar flexion) or a crouch gait (knee flexion associated with ankle dorsiflexion). Hamstring lengthening is performed to decrease stance knee flexion. However, this procedure carries the potential risk of weakening hip extension power as well as recurrence over time; therefore, surgeons have adopted a modified procedure wherein the semitendinosus and gracilis are transferred above the knee joint, along with lengthening of the semimembranosus and biceps femoris.

PURPOSE: The purpose of our study is to evaluate the differences between hamstring lengthening alone (HSL group) and hamstring lengthening plus transfer (HST group) in the treatment of flexed knee gait in ambulatory children with CP. We hypothesized that recurrence of increased knee flexion in the stance phase will be less in the HST group at long-term follow-up, and hip extensor power will be better preserved. **METHODS:** Fifty children with CP who underwent hamstring surgery for flexed knee gait were retrospectively reviewed. All subjects underwent a pre-operative gait study, a follow-up post-operative gait study, and a long-term gait study. The subjects were divided into two groups; HSL group (18 subjects) or HST group (32 subjects). The mean age at surgery was 9.9 ± 3.3 years. The mean follow-up time was 4.4 ± 0.9 (2.7-6.3) years.

RESULTS: On physical examination, both groups showed improvement in straight leg raise, knee extension, popliteal angle, and maximum knee extension in stance at the first post-op study, and maintained this improvement at the long-term follow-up, with the exception of straight leg raise, which slightly worsened in both groups at the final follow-up. Both groups improved maximum knee extension in stance at the initial follow-up, and maintained this at the long-term follow-up. Only the HST group showed significant ($p < 0.05$) improvement in the peak hip extension power in stance at the first post-op study, and this increased further at the final follow-up. In the HSL group, there was an initial slight decrease in the hip extension power, which subsequently increased to pre-operative values at the long-term study. Only the HST group showed increase of the average anterior pelvic tilt at the long-term follow-up study, although this was small in magnitude. There were two subjects who developed knee recurvatum at the post-op study, and both were in the HST group. **CONCLUSIONS:** There is no clear benefit in regards to recurrence when comparing HST to HSL in the long term. In both HSL and HST, there was reduction of stance phase knee flexion in the long term, with no clear advantage in either group. Longer follow-up is needed for additional recurrence information. There was greater improvement of hip extension power in the HST group, which may justify the additional operative time of the transfer. **SIGNIFICANCE:** This study helps pediatric orthopedic

surgeons choose between two different techniques to treat flexed knee gait in patients with CP by showing the long-term outcome of both procedures.

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2. Clin Rehabil. 2014 Nov 21. pii: 0269215514558642. [Epub ahead of print]

A study of whether video scoring is a reliable option for blinded scoring of the Gross Motor Function Measure-88.

Franki I1, Van den Broeck C2, De Cat J3, Molenaers G4, Vanderstraeten G2, Desloovere K3.

OBJECTIVE: To investigate the agreement between live and video scores of the Gross Motor Function Measure-88. **DESIGN:** Reliability study. **SUBJECTS:** Forty children with bilateral spastic cerebral palsy. **INTERVENTIONS:** Fifty evaluations were administered according to the test guidelines, and were videotaped. After a minimum interval of one month, the video recordings were again rated by the same assessor. Two physical therapy students also each scored the recordings twice, with a minimal interval of one month. **MAIN MEASURES:** Agreement between live and video scores as well as inter-rater and intra-rater agreement of the video scores were assessed using intra-class correlation coefficients (ICC), standard error of measurements (SEM), and smallest detectable changes (SDC). Weighted kappa coefficients were used to analyse individual items. **RESULTS:** The live and video scores from the same assessor showed good to very good agreement for the total score (ICC, 0.973; SEM, 2.28; SDC, 6.32) and dimensions B (ICC, 0.938), D (ICC, 0.965), and E (ICC, 0.992) but lower agreement for A (ICC, 0.720) and C (ICC, 0.667). Live-versus-video agreement for the total score was higher than inter-rater agreement by video (ICC, 0.949; SEM, 3.15; SDC, 8.73) but lower than intra-rater agreement by video (ICC, 0.989; SEM, 1.42; SDC, 3.96). **CONCLUSION:** The Gross Motor Function Measure-88 can be reliably scored using video recordings. The agreement between live and video scores is lower than the intra-rater reliability using video recordings only. Future clinical trial results should be interpreted using the appropriate SEM and SDC values.

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3. Disabil Rehabil. 2014 Nov 24:1-7. [Epub ahead of print]

Inter-rater agreement of the Arabic Gross Motor Classification System Expanded & Revised in children with cerebral palsy in Jordan.

Almasri N1, Saleh M.

Purpose: To examine the agreement among parents-report, research physiotherapists-report, and clinical physiotherapists-report using the Arabic-Gross Motor Classification System Expanded & Revised (GMFCS E&R) in classifying Jordanian children with cerebral palsy (CP). **Methods:** One-hundred and sixteen child with CP [mean age 4 years 7 months (SD=4 years 5 months)] participated in the study. Parents were asked to classify their children using the Arabic-GMFCS family report questionnaires. Clinical and research physiotherapists were asked to classify children using the Arabic-GMFCS E&R. Agreement between respondents was determined using Cohen's linear weighted kappa statistic. **Results:** An excellent level of agreement was reported between research physiotherapists and clinical physiotherapists, substantial level of agreement between parents and research physiotherapists and moderate agreement between parents and clinical physiotherapists. **Conclusions:** The Arabic-GMFCS E&R is a reliable classification system that can be administrated by health care providers and parents of children with CP in Jordan to help plan services for children. **Implications for Rehabilitation** The Arabic GMFCS E&R is a reliable and user friendly system that can be administrated by health care providers and parents of children with CP in Jordan to guide services planning. Classifying the children with CP should be performed by the team members (including the family and the children when they are transitioning from childhood to adulthood) independently first, then discussed among and consensus can be reached. The Arabic GMFCS E& R is a reliable classification system that can be used in Jordanian health care system despite the fact that therapists who practice in these settings were not familiar with this classification.

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4. J Am Acad Orthop Surg. 2014 Dec;22(12):782-790.**Identification of Common Gait Disruption Patterns in Children With Cerebral Palsy.**

Davids JR, Bagley AM.

Identification and classification of common gait deviation patterns in children with cerebral palsy facilitates communication between healthcare providers, provides insight into the natural history of functional ambulation, guides clinical decision making, and clarifies outcomes assessment. Previous classification schemes have been based on experiential and intuitive approaches or systematic and analytical approaches. The current gait disruption classification system has been refined to incorporate the most clinically useful aspects of previous systems. This paradigm uses the concept of primary versus compensatory deviations to identify common patterns and common causes for these patterns. The primary sagittal plane patterns include jump, crouch, and stiff gait. The primary transverse plane patterns include internal, external, and neutral progression gait. Apparent coronal plane deviation patterns are usually the consequence of sagittal and transverse plane deviations seen out of plane. Individualized assessment is essential because of the great variation in and combinations of possible patterns.

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[PMID: 25425613](#) [PubMed - as supplied by publisher]**5. Acta Orthop. 2014 Nov 27:1-4. [Epub ahead of print]****Head-shaft angle is a risk factor for hip displacement in children with cerebral palsy.**

Hermanson M1, Hägglund G, Riad J, Wagner P.

Background and purpose - Hip dislocation in children with cerebral palsy (CP) is a common and severe problem. The Swedish follow-up program for CP (CPUP) includes standardized monitoring of the hips. Migration percentage (MP) is a widely accepted measure of hip displacement. Coxa valga and valgus of the femoral head in relation to the femoral neck can be measured as the head-shaft angle (HSA). We assessed HSA as a risk factor for hip displacement in CP. **Patients and methods** - We analyzed radiographs of children within CPUP from selected regions of Sweden. Inclusion criteria were children with Gross Motor Function Classification System (GMFCS) levels III-V, MP of < 40% in both hips at the first radiograph, and a follow-up period of 5 years or until development of MP > 40% of either hip within 5 years. Risk ratio between children who differed in HSA by 1 degree was calculated and corrected for age, MP, and GMFCS level using multiple Poisson regression. **Results** - 145 children (73 boys) with a mean age of 3.5 (0.6-9.7) years at the initial radiograph were included. 51 children developed hip displacement whereas 94 children maintained a MP of < 40%. The risk ratio for hip displacement was 1.05 (p < 0.001; 95% CI 1.02-1.08). When comparing 2 children of the same age, GMFCS level, and MP, a 10-degree difference in HSA results in a 1.6-times higher risk of hip displacement in the child with the higher HSA. **Interpretation** - A high HSA appears to be a risk factor for hip displacement in children with CP.

[PMID: 25428756](#) [PubMed - as supplied by publisher]**6. J Exerc Rehabil. 2014 Oct 31;10(5):265-270. eCollection 2014.****The effects of horseback riding participation on the muscle tone and range of motion for children with spastic cerebral palsy.**

Baik K1, Byeun JK2, Baek JK3.

The objective of this research is to verify the effects of horseback riding participation on the muscle tone of pelvic limbs and articular range of motion for children with spastic cerebral palsy. The research target is 16 children with spastic cerebral palsy, 8 children for the experimental group and 8 children for the control group. As a tool to measure the muscle tone, Modified Ashworth Scale (MAS), was used and a goniometer was used to measure the range of motion (ROM). A therapeutic horseback riding program was conducted to an experimental group of 8 children with spastic cerebral palsy in the therapeutic horseback riding for 60 min a day, 2 days a week and a total of 12 weeks. The results are as follows: First, the participation in the therapeutic horseback riding program showed

a statistically significant difference in the muscle tone for the knee of children with spastic cerebral palsy ($P < 0.01$). Second, though the difference in knee muscle tone between the experimental group and the control group was statistically insignificant, the average was improved by the participation. Third, the participation in the therapeutic horseback riding program showed a statistically significant difference in the hip-joint motion range for the knee of children with spastic cerebral palsy ($P < 0.01$). Fourth, though the difference in the hip joint motion range between the experimental group and the control group was statistically insignificant, the average was improved by the participation.

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7. *Med Sci Sports Exerc.* 2014 Nov 21. [Epub ahead of print]

Quantification of Physical Activity and Sedentary Time in Adults with Cerebral Palsy.

Claridge EA1, McPhee PG, Timmons BW, Ginis KA, MacDonald MJ, Gorter JW.

PURPOSE: Objective and subjective quantification of habitual physical activity (HPA) and sedentary time in ambulatory and nonambulatory adults with cerebral palsy (CP). **METHODS:** We recruited a clinical sample of adults with CP ($N=42$; 21 female; mean age: 33.5 yr, SD 12.3 yr; Gross Motor Function Classification System (GMFCS) distribution: Level I ($n=5$), Level II ($n=9$), Level III ($n=10$), Level IV ($n=11$), and Level V ($n=7$). Objective measures of HPA and sedentary time were obtained by using ActiGraph GT3X accelerometers, at both hip and wrist sites. Three previously established cut-point values distinguishing light physical activity (LPA) and moderate-to-vigorous physical activity (MVPA) were evaluated across GMFCS levels. The concurrent validity of the self-report Physical Activity Recall Assessment for People with Spinal Cord Injury (PARA-SCI) was assessed for LPA and MVPA intensities in GMFCS levels II-V. **RESULTS:** Participants showed little reluctance to wearing accelerometers; one participant reported discomfort. Nonambulatory adults (GMFCS level IV-V) differed from ambulatory adults (GMFCS level I-III) for recorded activity counts (hip and wrist sites), minutes of MVPA with each cut-point value, and breaks from sedentary time (all $p < 0.05$). For the same measures, adults in GMFCS level III also differed from GMFCS level I (all $p < 0.05$). The PARA-SCI correlated significantly with accelerometer-derived minutes of MVPA per day ($r=0.396$, $p=0.014$) and per hour of monitoring time ($r=0.356$, $p=0.027$). **CONCLUSIONS:** Our findings support the use of accelerometers to objectively measure HPA and sedentary behavior in adults with CP across the severity spectrum, regardless of cut-point implementation. The PARA-SCI is a valid tool to capture subjectively reported patterns of MVPA in adults with CP who are GMFCS level II-V.

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8. *Acta Obstet Gynecol Scand.* 2014 Nov 21. doi: 10.1111/aogs.12544. [Epub ahead of print]

Effects of disability on pregnancy experiences among women with impaired mobility.

Iezzoni LI1, Wint AJ, Smeltzer SC, Ecker JL.

OBJECTIVE: Little is known about how functional impairments might affect the pregnancies of women with mobility disability. We aimed to explore complications that arise during pregnancy specifically related to physical functional impairments of women with significant mobility disabilities. **DESIGN:** Qualitative descriptive analysis. **SETTING:** Telephone interviews with women from 17 USA states. **SAMPLE:** 22 women with significant mobility difficulties who had delivered babies within the prior 10 years; most participants were recruited through social networks. **METHODS:** We conducted 2-hour, in-depth telephone interviews using a semi-structured, open-ended interview protocol. We used NVivo software to sort interview transcript texts for conventional content analyses. Main outcome measures Functional impairment-related complications during pregnancy. **RESULTS:** The women's mean (standard deviation) age was 34.8 (5.3) years. Most were white, well-educated, and higher income; 8 women had spinal cord injuries, 4 cerebral palsy, and 10 had other conditions; 18 used wheeled mobility aids; and 14 had cesarean deliveries (8 elective). Impairment-related complications during pregnancy included: falls; urinary tract and bladder problems; wheelchair fit and stability problems that reduced mobility and compromised safety; significant shortness of breath, sometimes requiring respiratory support; increased spasticity; bowel management difficulties; and skin integrity problems (this was rare, but multiple women greatly increased skin monitoring during pregnancy to prevent pressure ulcers). **CONCLUSIONS:** In addition to other pregnancy-associated health risks, women with mobility disabilities appear to experience problems relating to their functional impairments. Pre-conception planning and in-

depth discussions during early pregnancy could potentially assist women with mobility disabilities to anticipate and address these difficulties. This article is protected by copyright.

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Prevention and Cure

9. Dev Med Child Neurol. 2014 Nov 22. doi: 10.1111/dmcn.12642. [Epub ahead of print]

Introducing the term 'early developmental brain injury/interference' and a new framework for discussing cerebral palsy.

Shusterman M.

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10. Front Neurosci. 2014 Nov 7;8:359. eCollection 2014.

Barrier mechanisms in neonatal stroke.

Kratzer I, Chip S, Vexler ZS.

Clinical data continue to reveal that the incidence of perinatal stroke is high, similar to that in the elderly. Perinatal stroke leads to significant morbidity and severe long-term neurological and cognitive deficits, including cerebral palsy. Experimental models of cerebral ischemia in neonatal rodents have shown that the pathophysiology of perinatal brain damage is multifactorial. Cerebral vasculature undergoes substantial structural and functional changes during early postnatal brain development. Thus, the state of the vasculature could affect susceptibility of the neonatal brain to cerebral ischemia. In this review, we discuss some of the most recent findings regarding the neurovascular responses of the immature brain to focal arterial stroke in relation to neuroinflammation. We also discuss a possible role of the neonatal blood-CSF barrier in modulating inflammation and the long-term effects of early neurovascular integrity after neonatal stroke on angiogenesis and neurogenesis.

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11. J Neurochem. 2014 Nov 25. doi: 10.1111/jnc.12997. [Epub ahead of print]

Elevated spinal monoamine neurotransmitters after antenatal hypoxia-ischemia in rabbit cerebral palsy model.

Drobyshevsky A1, Takada SH, Luo K, Derrick M, Yu L, Quinlan KA, Vasquez-Vivar J, Nogueira MI, Tan S.

We hypothesized that a deficiency in the descending serotonergic input to spinal cord may underlie postnatal muscle hypertonia after global antenatal hypoxic-ischemic injury in a rabbit model of cerebral palsy. Neurotransmitter content was determined by HPLC in the spinal cord of newborns with and without muscle hypertonia after fetal global hypoxic-ischemic brain injury and naïve controls. Contrary to our hypothesis, serotonin levels in both cervical and lumbar expansions and norepinephrine in cervical expansion were increased in hypertonic kits relative to non-hypertonic kits and controls, with unchanged number of serotonergic cells in caudal raphe by stereological count. Serotonergic fiber length per unit of volume was also increased in hypertonic kits' cervical and lumbar spinal cord, both in dorsal and ventral horns. Gene expression of serotonin transporter was increased and 5-HT₂ receptors were decreased in hypertonic kits relative to controls in cervical and lumbar cord. Intrathecal administration of nonselective serotonin receptor inhibitor methysergide decreased muscle tone in hypertonic kits only. Conversely, intrathecal administration of serotonin solution increased muscle tone only in non-hypertonic kits. We speculate that maturation of serotonergic system in spinal cord may be directly affected by decreased corticospinal connectivity after antenatal hypoxic-ischemic brain injury. This article is protected by

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12. Neural Regen Res. 2014 Oct 1;9(19):1763-1769.

Response of the sensorimotor cortex of cerebral palsy rats receiving transplantation of vascular endothelial growth factor 165-transfected neural stem cells.

Tan J, Zheng X, Zhang S, Yang Y, Wang X, Yu X, Zhong L.

Neural stem cells are characterized by the ability to differentiate and stably express exogenous genes. Vascular endothelial growth factor plays a role in protecting local blood vessels and neurons of newborn rats with hypoxic-ischemic encephalopathy. Transplantation of vascular endothelial growth factor-transfected neural stem cells may be neuroprotective in rats with cerebral palsy. In this study, 7-day-old Sprague-Dawley rats were divided into five groups: (1) sham operation (control), (2) cerebral palsy model alone or with (3) phosphate-buffered saline, (4) vascular endothelial growth factor 165 + neural stem cells, or (5) neural stem cells alone. The cerebral palsy model was established by ligating the left common carotid artery followed by exposure to hypoxia. Phosphate-buffered saline, vascular endothelial growth factor + neural stem cells, and neural stem cells alone were administered into the sensorimotor cortex using the stereotaxic instrument and microsyringe. After transplantation, the radial-arm water maze test and holding test were performed. Immunohistochemistry for vascular endothelial growth factor and histology using hematoxylin-eosin were performed on cerebral cortex. Results revealed that the number of vascular endothelial growth factor-positive cells in cerebral palsy rats transplanted with vascular endothelial growth factor-transfected neural stem cells was increased, the time for finding water and the finding repetitions were reduced, the holding time was prolonged, and the degree of cell degeneration or necrosis was reduced. These findings indicate that the transplantation of vascular endothelial growth factor-transfected neural stem cells alleviates brain damage and cognitive deficits, and is neuroprotective in neonatal rats with hypoxia ischemic-mediated cerebral palsy.

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13. Pediatrics. 2014 Nov 24. pii: peds.2014-1926. [Epub ahead of print]

Motor Severity in Children With Cerebral Palsy Studied in a High-Resource and Low-Resource Country.

Benfer KA1, Jordan R2, Bandaranayake S3, Finn C2, Ware RS4, Boyd RN2.

OBJECTIVES: To compare the patterns of motor type and gross motor functional severity in preschool-aged children with cerebral palsy (CP) in Bangladesh and Australia.
METHODS: We used comparison of 2 prospective studies. A total of 300 children with CP were aged 18 to 36 months, 219 Australian children (mean age, 26.6 months; 141 males) recruited through tertiary and community services, and 81 clinic-attendees born in Bangladesh (mean age, 27.5 months; 50 males). All children had diagnosis confirmed by an Australian physician, and birth and developmental history collected on the Physician Checklist. All children were classified by the same raters between countries using the Gross Motor Function Classification System (GMFCS), and motor type and distribution. **RESULTS:** There were more children from GMFCS I-II in the Australian sample (GMFCS I, $P < .01$; III, $P < .01$; V, $P = .03$). The patterns of motor type also differed significantly with more spasticity and less dyskinetic types in the Australian sample (spasticity, $P < .01$; dystonia, $P < .01$; athetosis, $P < .01$). Birth risk factors were more common in the Bangladesh sample, with risk factors of low Apgar scores (Australia, $P < .01$), lethargy/seizures (Australia, $P = .01$), and term birth (Bangladesh, $P = .03$) associated with poorer gross motor function. Cognitive impairments were significantly more common in the Bangladesh children ($P < .01$), and visual impairments more common in Australia ($P < .01$). **CONCLUSIONS:** Patterns of functional severity, motor type, comorbidities, etiology, and environmental risk factors differed markedly between settings. Our results contribute to understanding the patterns of CP in low-resource settings, and may assist in optimizing service delivery and prioritizing appropriate early interventions for children with CP in these settings.

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14. Pediatrics. 2014 Nov 24. pii: peds.2014-0945. [Epub ahead of print]

Cerebral Palsy Among Children Born Moderately and Late Preterm.

Hirvonen M1, Ojala R2, Korhonen P2, Haataja P2, Eriksson K3, Gissler M4, Luukkaala T5, Tammela O2.

OBJECTIVE: To compare the incidence of and risk factors for cerebral palsy (CP) in moderately preterm (MP) (32+0-33+6 weeks) and late preterm (LP) (34+0-36+6 weeks) infants with those in very preterm (VP) (<32+0 weeks) and term infants (=37 weeks). **METHODS:** The national register study included all live-born infants in Finland from 1991 to 2008. Infants who died before the age of 1 year, had any major congenital anomaly, or had missing data were excluded. A total of 1,018,302 infants were included in the analysis and they were analyzed in 4 subgroups (VP, MP, LP, and term) and 3 time periods (1991-1995, 1996-2001, and 2002-2008). **RESULTS:** By the age of 7 years, 2242 children with CP were diagnosed (0.2%). CP incidence was 8.7% in the VP, 2.4% in the MP, 0.6% in the LP, and 0.1% in the term group. The risk of CP was highest in the study period 1991-1995 in all groups. Factors predictive of an increased CP risk in the MP and LP groups included resuscitation at birth (odds ratio 1.60; 95% CI 1.01-2.53 and 1.78; 1.09-2.90), antibiotic treatment during the first hospitalization (1.63; 1.08-2.45 and 1.67; 1.13-2.44), 1-minute Apgar score <7 (1.70; 1.15-2.52 and 1.80; 1.21-2.67) and intracranial hemorrhage (7.18; 3.60-14.3 and 12.8; 5.58-29.2). **CONCLUSIONS:** The incidence of CP is higher in LP and MP infants compared with term infants. There is a nonlinear decrease in incidence over time and with increasing gestational age.

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