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Professor Nadia Badawi

Macquarie Group Foundation Chair of Cerebral Palsy
PO Box 560, Darlinghurst, New South Wales 2010 Australia

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Interventions and Management

1. Dev Med Child Neurol. 2014 Feb;56(2):185-9. doi: 10.1111/dmcn.12348. Epub 2013 Nov 25.

The stability of the Manual Ability Classification System over time.

Ohrvall AM, Krumlinde-Sundholm L, Eliasson AC.

AIM: To evaluate the stability over time of the Manual Ability Classification System (MACS) levels. **METHOD:** The study group comprised 1267 children with cerebral palsy (746 males, 521 females) who were followed from 2005 to 2010 with two or more registered MACS classifications rated at least 1 year apart. Thirty-five percent of the children (n=445) had four MACS registrations. The children were between 4 and 17 years old at their first rating, The stability over time was also compared between children who were younger (4y of age) or older ($\geq 10y$) at the time of their first classification. **RESULTS:** An excellent stability was found between two ratings at 1-year intervals with an intraclass correlation coefficient (ICC) of 0.97 (95% CI 0.97-0.97) and 82% agreement (n=1267). The stability was also excellent for two ratings performed 3 to 5 years apart (ICC 0.96; 95% CI 0.95-0.97) with an agreement of 78% (n=445). Across four ratings, 70% of the children remained at the same level. The results were similar for younger and older children, indicating that stability was not influenced by age. **INTERPRETATION:** This study provides evidence that MACS levels are stable over time and that the classification has predictive value.

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[PMID: 24417511](https://pubmed.ncbi.nlm.nih.gov/24417511/) [PubMed - in process]

2. Phys Ther. 2014 Jan 10. [Epub ahead of print]

Upper Extremity Strength Measurement for Children With Cerebral Palsy: A Systematic Review of Available Instruments.

Dekkers KJ, Rameckers EA, Smeets RJ, Janssen-Potten YJ.

BACKGROUND: In order to make inferences about strength related to development or treatment interventions it is important to use measurement instruments that have sound clinimetric properties. **PURPOSE:** The objective of this systematic review is to systematically evaluate the level of evidence of the clinimetric properties of instruments for measuring upper extremity muscle strength at the "body functions & structures" level of the ICF-CY for children with Cerebral Palsy (CP). **DATA SOURCES:** A systematic search of databases PubMed, EMBASE, OTseeker,

CINAHL, PEDRO and Medline databases up to November 2012 was performed. **STUDY SELECTION:** Two independent raters identified and examined studies that reported upper extremity strength measurement instruments for children with CP aged 0 to 18 years. **DATA EXTRACTION:** The COSMIN checklist with 4-point rating scale was used by two independent raters to evaluate the methodological quality of the included studies. "Best evidence synthesis" was performed using COSMIN outcomes and the quality of the clinimetric properties. **DATA SYNTHESIS:** Six different measurement instruments were identified. Test-retest, inter-rater and intra-rater reliability were investigated. Two test-retest reliability studies were rated as "fair" for the level of evidence. All other studies were rated as "unknown" for the level of evidence. **LIMITATIONS:** The paucity of literature, which describes clinimetric properties, specially other than reliability, of upper limb strength measurement instruments for children with CP is a limitation. **CONCLUSIONS:** For measuring grip strength the Jamar® dynamometer is recommended and for other muscle groups HHD dynamometry. MMT can be used in case of limited (below MMT grade 4) wrist strength or for total upper limb muscle strength. Based on lacking information regarding other clinimetric properties one should be cautious with the interpretation of the results.

[PMID: 24415772](#) [PubMed - as supplied by publisher]

3. J Child Orthop. 2013 Nov;7(5):389-394. Epub 2013 Oct 6.

Surgical management of spasticity.

Roberts A.

Intractable and severe spasticity in childhood has the ability to impact on the quality of life, function and care of the child. Where medical and physical measures have proved insufficient, a surgical approach may be pursued. Irrespective of the underlying pathology, intrathecal baclofen will reduce spasticity in a controllable and reversible fashion, whereas selective dorsal rhizotomy is reserved for the management of bilateral cerebral palsy due to early birth. Owing to the potential for complications of intrathecal baclofen and the permanence of selective dorsal rhizotomy, careful selection and preparation are required to produce satisfactory results.

[PMID: 24432100](#) [PubMed - as supplied by publisher] [PMCID: PMC3838521](#) [Available on 2014/11/1]

4. J Child Orthop. 2013 Nov;7(5):419-423. Epub 2013 Aug 28.

Operative treatment for spinal deformities in cerebral palsy.

Hasler CC.

The higher the functional impairment, the more likely patients with cerebral palsy (CP) are to develop a scoliotic deformity. This is usually long-sweeping, C-shaped, and progressive in nature, since the causes of the deformity, such as muscular weakness, imbalance, and osteoporosis, persist through adulthood. In contrast to idiopathic scoliosis, not only is the spine deformed, the patient is also sick. This multimorbidity warrants a multidisciplinary approach with close involvement of the caregivers from the beginning. Brace treatment is usually ineffective or intolerable in light of the mostly stiff and severe deformities and the poor nutritional status. The pros and cons of surgical correction need to be weighed up when pelvic obliquity, subsequent loss of sitting balance, pressure sores, and pain due to impingement of the rib cage on the ileum become issues. General risks of, for example, pulmonary or urogenital infections, pulmonary failure, the need for a tracheostoma, permanent home ventilation, and death add to the particular surgery-related hazards, such as excessive bleeding, surgical site infections, pseudarthrosis, implant failure, and dural tears with leakage of cerebrospinal fluid. The overall complication rate averages around 25 %. From an orthopedic perspective, stiffness, marked deformities including sagittal profile disturbances and pelvic obliquity, as well as osteoporosis are the main challenges. In nonambulatory patients, long fusions from T2/ T3 with forces distributed over all segments, low-profile anchors in areas of poor soft tissue coverage (sublaminar bands, wires), and strong lumbosacropelvic modern screw fixation in combination with meticulous fusion techniques (facetectomies, laminar decortication, use of local autologous bone) and hemostasis can be employed to keep the rate of surgical and implant-related complications at an acceptably low level. Excessive posterior release techniques, osteotomies, or even vertebrectomies in cases of very severe short-angled deformity mostly prevent anterior one- or two-stage releases. Despite improved operative techniques and implants with predictable and satisfactory deformity corrections, the comorbidities and quality-of-life related issues demand a thorough preoperative, multidisciplinary decision-making process that takes ethical and economic aspects into consideration.

[PMID: 24432105](#) [PubMed - as supplied by publisher] PMCID: PMC3838513 [Available on 2014/11/1]

5. J Child Orthop. 2013 Nov;7(5):415-418. Epub 2013 Aug 30.

Management of spinal deformity in cerebral palsy: conservative treatment.

Rutz E, Brunner R.

INTRODUCTION: The incidence of scoliosis in Cerebral Palsy (CP) is directly related to the Gross Motor Function Classification System (GMFCS) level. The natural history of untreated scoliosis in patients with CP is one of progression and factors implicated in deterioration include type of involvement (quadriplegia), poor functional status (nonambulatory, GMFCS levels IV and V), and curve location (thoracolumbar). The generally accepted incidence in the overall CP population is 20-25 %. **MATERIALS AND METHODS:** We recently published our short term results for 31 children treated with a short lumbar brace. In cases of a "positive hands up test" we recommend a short lumbar brace, and in patients with scoliosis with a Cobb angle >20° a double shelled brace. **RESULTS:** In our study, there was a correction of 37 % for the lumbar Cobb angle and 39 % for the thoracic Cobb angle at a mean follow-up of 28 months. **CONCLUSION:** The incidence of scoliosis in the overall CP population is 20-25 % and is directly related to the GMFCS level. Therefore, we recommend early treatment and prescribe a short lumbar brace in patients with dynamic instability of the trunk, and in scoliosis with a Cobb angle >20° a double shelled brace.

[PMID: 24432104](#) [PubMed - as supplied by publisher] PMCID: PMC3838520 [Available on 2014/11/1]

6. J Child Orthop. 2013 Dec;7(6):487-500. doi: 10.1007/s11832-013-0536-1. Epub 2013 Oct 15.

Risk factors and complications in hip reconstruction for nonambulatory patients with cerebral palsy.

Ruzbarsky JJ1, Beck NA2, Baldwin KD1, Sankar WN1, Flynn JM1, Spiegel DA1.

BACKGROUND: Hip dysplasia is prevalent in nonambulatory children with cerebral palsy, and may contribute to a decreased quality of life (Lonstein in J Pediatr Orthop 6:521-526, 1). Reconstructive procedures such as a femoral varus derotation osteotomy with or without a pelvic osteotomy are commonly employed with the goal of achieving and maintaining well reduced hips. **PURPOSES:** The goals of this study are both to characterize the complications of reconstructive procedures and to identify risk factors that may contribute to these complications. **PATIENTS AND METHODS:** A retrospective analysis was conducted among 61 nonambulatory children (93 hips) with cerebral palsy who underwent a femoral varus derotation osteotomy, with or without an open reduction and/or pelvic osteotomy, from 1992 through 2008 at our institution. The average patient age was 8.1 years (2.6-14.7) and the mean follow-up time was 5.9 years (2.1-15.9). **RESULTS:** The cumulative complication rate per patient including failures to cure was 47.6 %. Spica casting was found to be a risk factor for all complications (P = 0.023); whereas patients younger than 6 years old (P = 0.013) and children with a tracheostomy (P = 0.004) were found to be risk factors for resubluxation following surgery. **CONCLUSIONS:** Although reported complication rates of hip reconstructive procedures performed upon children with cerebral palsy have varied considerably, those with more severe disease have experienced more complications. We report our tertiary referral center's complication rate and our institutional experiences with risk factors for complications and failures to cure.

LEVEL OF EVIDENCE: IV, Retrospective case series.

[PMID: 24432112](#) [PubMed] PMCID: PMC3886352 [Available on 2014/12/1]

7. J Child Orthop. 2013 Nov;7(5):401-406. Epub 2013 Sep 15.

Importance of hip problems in daily activities for cerebral palsy patients.

Viehweger E.

[PMID: 24432102](#) [PubMed - as supplied by publisher] PMCID: PMC3838522 [Available on 2014/11/1]

8. J Child Orthop. 2013 Nov;7(5):407-413. Epub 2013 Aug 18.**Hip surveillance and management of the displaced hip in cerebral palsy.**

Robb JE1, Hägglund G2.

INTRODUCTION: This article provides an overview of the management of a displaced hip in children with cerebral palsy and considers surveillance programmes, principles of surgical reconstruction and options for the salvage of an unreconstructable hip in these children. **CONCLUSION:** Hip dislocation in CP is potentially preventable if children are included from an early age in a surveillance programme that includes repeat radiographic and clinical examinations, and preventive treatment for hips that are displacing. A surveillance programme should be based on the child's age, GMFCS level and migration percentage (MP), and surgical prevention may be considered in children with a MP exceeding 33 %.

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9. J Child Orthop. 2013 Nov;7(5):383-387. Epub 2013 Aug 28.**Botulinum toxin A treatment of the lower extremities in children with cerebral palsy.**

Molenaers G1, Fagard K2, Van Campenhout A1, Desloovere K3.

OBJECTIVES: In the last 2 decades, BTX-A is increasingly being used in the management of spasticity in children with Cerebral Palsy (CP) and there is no doubt about its effect on range of motion, spasticity reduction and gait pattern in this patient population. However, in daily practice, there is still an ongoing search for the best way to apply BTX-A. Two studies were set up to evaluate how successful an integrated multilevel treatment approach is in children with CP. The first study identifies crucial factors within the treatment strategy which may predict the outcome. The second study evaluates the efficacy of repeated BTX-A injections. **METHODS:** Patient selection was based on following criteria: diagnosis of CP, lower limb BTX-A treatment, age at time of treatment <24 years, no combined surgery at the time of BTX-A injections, 3D gait analysis and clinical evaluation pre and 2 months post BTX-A injections. The first study included the last treatment of 577 patients. In the second study, the first and last BTX-A treatment of 222 children were included. The Goal Attainment Scale (GAS) was used to evaluate the functional outcome of each treatment session. **RESULTS:** In the first study, the mean GAS score of the total group was 51.7 (± 7.5). Considering a converted total score of 50 as cut-off score for successful treatment, 67.1 % of the treatments were successful. Significantly higher GAS scores were found in mildly involved children compared to more involved children ($p < 0.0001$) and for multilevel injections or injections in the distal muscle groups only compared to injections in the proximal muscles of the lower limb only ($p < 0.0001$). Other crucial factors for a successful outcome were amount of physical therapy per week ($p=0.0026$), post injection casting ($p=0.005$) and frequency of using day and night orthoses after injection ($p < 0.0001$). In the second study, the mean GAS score of the total group decreased from 54.8 (± 6.8) at the first treatment to 50.7 (± 6.9) at the last treatment, indicating that on average, repeated BTX-A treatment is successful. **CONCLUSION:** The integrated multilevel BTX-A approach is successful in children with CP. Several factors might help the clinician to select patients that are most likely to benefit from the treatment, to assure the most optimal treatment strategy and to predict the outcome. Each treatment should be carefully planned and goals should be well chosen, because the effectiveness of the BTX-A treatment may decrease with increasing number of treatments in the same patient.

[PMID: 24432099](#) [PubMed - as supplied by publisher] [PMCID: PMC3838518](#) [Available on 2014/11/1]

10. J Child Orthop. 2013 Nov;7(5):435-43. doi: 10.1007/s11832-013-0505-8. Epub 2013 Jun 29.**Flexed-knee gait in children with cerebral palsy: a 10-year follow-up study.**

Haumont T1, Church C2, Hager S2, Cornes MJ2, Poljak D2, Lennon N3, Henley J2, Taylor D2, Niiler T2, Miller F2.

BACKGROUND: While several studies have evaluated the short-term effectiveness of conservative and surgical treatment of flexed-knee gait in children with cerebral palsy (CP), few have explored the long-term outcomes using gait analysis. The purpose of this study was to examine, through gait analysis, the 10-year outcomes of flexed-knee gait in children with CP. **METHODS:** Ninety-seven children with spastic CP who walked with a flexed-knee gait

underwent two gait evaluations [age 6.1 ± 2.1 and 16.2 ± 2.3 years, Gross Motor Function Classification System (GMFCS) I (12), II (45), III (37), IV (3)]. Limbs with knee flexion at initial contact $>15^\circ$ were considered walking with a flexed-knee gait and were included in the study ($n = 185$). Kinematic data were collected using an eight-camera motion analysis system (Motion Analysis, Santa Rosa, CA). Surgical and therapeutic interventions were not controlled. RESULTS: A comparison between the two gait studies showed an overall improvement in gait at 10 years follow-up. Significant improvements were seen in knee flexion at initial contact, Gait Deviation Index (GDI), Gross Motor Function Measure (GMFM), and gait speed ($P < 0.01$ for all). Outcome was also evaluated based on the severity of flexed-knee gait at the initial visit, with functional skills and overall gait (GDI) improving in all groups ($P < 0.01$ for all). The group with a severe flexed-knee gait exhibited the most improvement, while subjects with a mild flexed-knee improved the least. CONCLUSIONS: Children at a specialty hospital whose orthopedic care included gait analysis and multi-level surgery showed improvement of flexed-knee gait and gross motor function over a 10-year course, regardless of the initial severity.

[PMID: 24432107](#) [PubMed] PMID: PMC3838511 [Available on 2014/11/1]

11. Am J Phys Med Rehabil. 2014 Feb;93(2):122-9. doi: 10.1097/PHM.0b013e3182a54207.

Feedback system based on plantar pressure for monitoring toe-walking strides in children with cerebral palsy.

Pu F, Fan X, Yang Y, Chen W, Li S, Li D, Fan Y.

OBJECTIVE: The aim of this study was to develop a feedback system to assist gait rehabilitation of cerebral palsy (CP) toe walkers with dynamic equinus. DESIGN: Plantar pressure of the forefoot and the heel was collected by sensorized insoles embedded in custom-built shoes and transmitted to a smartphone via Bluetooth. Dynamic foot pressure index of each stride was calculated by purpose-designed software running in the smartphone to distinguish toe-walking strides from normal strides in real time. An auditory signal would be produced to alert the patient each time a toe-walking stride was detected. RESULTS: For CP toe walkers, the one-way analysis of variance indicated a significant difference ($F_{1,14} = 19.492$, $P = 0.001$) in dynamic foot pressure index between the affected side (31.4 ± 12.0) and the unaffected side (58.6 ± 2.5). In addition, the validation test showed that this system can distinguish toe-walking strides from normal strides of children with CP with an accuracy of 95.3%. CONCLUSIONS: This system was able to monitor the toe-walking strides of children with CP in real time and had the potential to enhance rehabilitation training efficiency and correct toe-walking gait in children with CP with dynamic equinus.

[PMID: 24434888](#) [PubMed - in process]

12. J Child Orthop. 2013 Nov;7(5):425-33. doi: 10.1007/s11832-013-0503-x. Epub 2013 Jun 18.

The effects of botulinum toxin injection frequency on calf muscle growth in young children with spastic cerebral palsy: a 12-month prospective study.

Barber L1, Hastings-Ison T2, Baker R3, Kerr Graham H4, Barrett R5, Lichtwark G6.

PURPOSE: This study was a 12-month prospective investigation of changes in the medial gastrocnemius (MG) muscle morphology in children aged 2-5 years with spastic cerebral palsy (CP) who had received no previous intramuscular injections of botulinum neurotoxin type-A (BoNT-A) and were randomised to receive either single or multiple (three) BoNT-A injections to the gastrocsoleus. MG morphological changes were compared to age-matched typically developing (TD) peers. METHODS: Thirteen children with spastic CP with a mean age of 45 (15) months and 18 TD children with a mean age of 48 (14) months participated in the study. The principal outcome measures were MG muscle volume, fascicle length, pennation angle and physiological cross-sectional area (PCSA), which were obtained using 2D and 3D ultrasound. RESULTS: The single and multiple injection frequency groups significantly increased MG muscle volume at 12 months relative to the baseline by 13 and 15 %, respectively. There were no significant differences in the MG muscle volume 28.5 (12.3) versus 30.3 (3.8) ml, fascicle length 48.0 (10.4) versus 44.8 (1.2) mm or PCSA 7.0 (1.2) versus 6.6 (1.7) cm² between the single and multiple injection groups, respectively, at 12 months follow-up. The change in MG muscle volume in the single and multiple injection groups was significantly lower than the TD peers by 66 and 60 %, respectively. INTERPRETATION: In young children with spastic CP, naive to BoNT-A treatment, MG muscle growth over 12

months does not appear to be influenced by intramuscular BoNT-A injection frequency. However, MG muscle growth in the spastic CP groups was significantly lower than the age-matched TD peers. It is unclear whether this is an effect of intramuscular BoNT-A injections or reduced growth rates in children with spastic CP in general. Controlled investigations and longitudinal studies with multiple measurement time points are required in order to determine the influence of BoNT-A treatment on muscle physiological and mechanical growth factors in young children with spastic CP.

[PMID: 24432106](#) [PubMed] PMID: PMC3838523 [Available on 2014/11/1]

13. J Child Orthop. 2013 Nov;7(5):379-382. Epub 2013 Aug 14.

Lever arm dysfunction in cerebral palsy gait.

Theologis T.

Skeletal structures act as lever arms during walking. Muscle activity and the ground reaction against gravity exert forces on the skeleton, which generate torque (moments) around joints. These lead to the sequence of movements which form normal human gait. Skeletal deformities in cerebral palsy (CP) affect the function of bones as lever arms and compromise gait. Lever arm dysfunction should be carefully considered when contemplating treatment to improve gait in children with CP.

[PMID: 24432098](#) [PubMed - as supplied by publisher] PMID: PMC3838510 [Available on 2014/11/1]

14. J Child Orthop. 2013 Nov;7(5):373-377. Epub 2013 Sep 14.

Overview of foot deformity management in children with cerebral palsy.

Sees JP, Miller F.

Foot deformities in children with cerebral palsy are common. The natural history of the deformities of the feet is very variable and very unpredictable in young children less than 5 years old. Treatment for the young children should be primarily with orthotics and manual therapy. Equinus is the most common deformity, with orthotics augmented with botulinum toxin being the primary management in young children. When fixed deformity develops lengthening only the muscle which is contracted is preferred. Varus deformity of the feet is often associated with equinus, and can almost always be managed with orthotics until 8 or 10 years of age. Planovalgus is the most common deformity in children with bilateral lower extremity spasticity. The primary management is orthotics until the child no longer tolerates the orthotic; then surgical management needs to consider all the deformities and all should be corrected. This requires correcting the subtalar subluxation with calcaneal lengthening or fusion, medial midfoot correction with osteotomy or fusion.

[PMID: 24432097](#) [PubMed - as supplied by publisher] PMID: PMC3838514 [Available on 2014/11/1]

15. Ortop Traumatol Rehabil. 2013 Oct 24;15(4):325-33. doi: 10.5604/15093492.1073831.

Surgical treatment of advanced, stiff neurologic cavovarus foot in adults.

Kołodziej L, Dobiecki K, Sadlik B.

Background. Cavovarus foot is a complex, three-dimensional deformity of neuromuscular origin. A rigid cavovarus deformity causes difficulty in walking, instability, fatigue fractures, calluses and trophic ulcers in the overloaded lateral part of the foot and requires wearing orthopaedic shoes. The aim of the study was to evaluate current surgical techniques in the treatment of rigid cavovarus foot in adults. Material and methods. This paper is a retrospective analysis of 14 patients (15 feet) treated surgically at our centre who presented with advanced cavovarus foot caused by a spectrum of neuromuscular diseases such as Charcot-Marie-Tooth, poliomyelitis, cerebral palsy, myelomeningocele, diabetes (Charcot's neuroarthropathy), sequelae of strokes and CNS injuries, compartment syndrome and inveterate sciatic nerve injuries. Average patient age was 53 years. Average follow-up period was 24 months (range: 18-58). The AOFAS scoring system was used to assess treatment results. Results.

The mean AOFAS score before surgery was 24 (range: 8-35) points and increased to 60 (range: 40-76) points after surgery. A stable, plantigrade, painless foot was achieved in all treated patients. Conclusions. 1. Surgical treatment of advanced cavovarus foot of neuromuscular origin should be carried out in a staged process with reassessment and adaptation of subsequent stages rather than following a rigid scheme. 2. The surgeon must be familiar with a number of techniques and procedures in order to correct the bony deformity and achieve muscle imbalance correction in a single-stage surgery.

[PMID: 24431270](#) [PubMed - in process]

16. Am J Phys Med Rehabil. 2014 Feb;93(2):114-21. doi: 10.1097/PHM.0b013e3182a541a4.

Effect of whole-body vibration on muscle strength and balance in diplegic cerebral palsy: a randomized controlled trial.

EI-Shamy SM.

OBJECTIVE: The purpose of this study was to investigate the effects of whole-body vibration training on muscle strength and balance in children with diplegic cerebral palsy. **DESIGN:** Fifteen children were assigned to the experimental group, which received whole-body vibration training (9 mins per day, 5 days per week). Another 15 were assigned to the control group, which participated in a traditional physical therapy exercise program for 3 successive months. Baseline and posttreatment assessments were performed using the Biodex isokinetic dynamometer to evaluate the knee extensors peak torque at 60 degrees per second and 90 degrees per second and using the Biodex balance system to evaluate stability index. **RESULTS:** The children in the experimental group showed a significant improvement when compared with those in the control group ($P < 0.001$). The peak torque at 60 degrees per second and 90 degrees per second after treatment was 28.8 ± 0.45 and 47.5 ± 0.7 N · m and 30.9 ± 0.68 and 54.2 ± 1.7 N · m for the control and the experimental group, respectively. The overall stability index after treatment was 2.75 and 2.2 for the control group and the experimental group, respectively. **CONCLUSIONS:** Whole-body vibration training may be a useful tool for improving muscle strength and balance in children with diplegic cerebral palsy.

[PMID: 24434887](#) [PubMed - in process]

17. J Child Orthop. 2013 Dec;7(6):537-42. doi: 10.1007/s11832-013-0540-5. Epub 2013 Nov 8.

The efficacy of neuroprosthesis in young hemiplegic patients, measured by three different gait indices: early results.

Danino B, Khamis S, Hemo Y, Batt R, Snir E, Wientroub S, Hayek S.

PURPOSE: To evaluate functional electrical stimulation (FES) neuroprosthesis as a method to improve gait in hemiplegic patients, using three different gait scoring methods as measures. **METHODS:** Five hemiplegic patients (four with cerebral palsy at GMFCS I, one with diffuse pontine glioma) with a mean age of 16.5 years were given a FES neuroprosthesis (NESS(®) L300™) that was applied and calibrated individually. After an adaptation period during which the participants increased their daily use of the neuroprosthesis, gait was assessed with the stimulation off and with the FES on. Kinematic, kinetic, and temporal spatial data were determined using motion analysis and summarized by three scoring methods: Gait Profile Score (GPS), Gait Deviation Index (GDI), and Gillette Gait Index (GGI). Indices were calculated using the Gaitabase program available online. Patients were followed for a minimum of 1 year. **RESULTS:** When comparing gait with and without stimulation, all scoring methods showed improvement. GPS and GDI of the affected leg were significantly improved: 12.23 - 10.23° ($p = 0.017$) and 72.36 - 78.08 ($p = 0.002$), respectively. By applying the movement analysis profile, the decomposed GPS score, we found that only the ankle dorsiflexion and the foot progression angle were significantly changed. GGI of the affected leg showed improvement, but without statistical significance: 168.88 - 131.64 ($p = 0.221$). Total GPS of legs and the GPS, GDI, and GGI of the nonaffected leg showed improvement without statistical significance. At the 1-year follow-up, all patients expressed high satisfaction and continued to use the device. **CONCLUSIONS:** Dorsiflexion functional electrical stimulation improves gait in hemiplegic patients, as reflected by GPS, GDI, and GGI.

[PMID: 24432118](#) [PubMed] [PMCID: PMC3886350](#) [Available on 2014/12/1]

18. NeuroRehabilitation. 2014 Jan 13. [Epub ahead of print]**Innovative strength training-induced neuroplasticity and increased muscle size and strength in children with spastic cerebral palsy: An experimenter-blind case study - three-month follow-up.**

Lee DR1, Kim YH2, Kim DA3, Lee JA4, Hwang PW4, Lee MJ5, You SH6.

BACKGROUND: In children with cerebral palsy (CP), the never-learned-to-use (NLTU) effect and underutilization suppress the normal development of cortical plasticity in the paretic limb, which further inhibits its functional use and increases associated muscle weakness. **OBJECTIVE:** To highlight the effects of a novel comprehensive hand repetitive intensive strengthening training system on neuroplastic changes associated with upper extremity (UE) muscle strength and motor performance in children with spastic hemiplegic CP. **METHOD:** Two children with spastic hemiplegic CP were recruited. Intervention with the comprehensive hand repetitive intensive strengthening training system was provided for 60 min a day, three times a week, for 10 weeks. Neuroplastic changes, muscle size, strength, and associated motor function were measured using functional magnetic resonance imaging (MRI), ultrasound imaging, and standardized motor tests, respectively. **RESULTS:** The functional MRI data showed that the comprehensive hand repetitive intensive strengthening training intervention produced measurable neuroplastic changes in the neural substrates associated with motor control and learning. These neuroplastic changes were associated with increased muscle size, strength and motor function. **CONCLUSIONS:** These results provide compelling evidence of neuroplastic changes and associated improvements in muscle size and motor function following innovative upper extremity strengthening exercise.

[PMID: 24419014](#) [PubMed - as supplied by publisher]

19. Int J Pediatr Otorhinolaryngol. 2013 Dec 25. pii: S0165-5876(13) 00665-4. doi: 10.1016/j.ijporl.2013.12.019. [Epub ahead of print]**"Floppy airway" in older children with cerebral palsy: The laryngomalacia-reflux-dystonia syndrome.**

Karkos PD1, Papouliakos S2.

[PMID: 24411814](#) [PubMed - as supplied by publisher]

20. Anesth Prog. 2013 Winter;60(4):153-61. doi: 10.2344/0003-3006-60.4.153.**Risk factors with intravenous sedation for patients with disabilities.**

Yoshikawa F, Tamaki Y, Okumura H, Miwa Z, Ishikawa M, Shimoyama K, Nakamura Z, Kunimori H, Jinno S, Kohase H, Fukayama H.

The purpose of this study was to identify the risk factors associated with low peripheral oxygen saturation (SpO₂) and delayed recovery of dental patients with disabilities after intravenous sedation. A total of 1213 patients with disabilities were retrospectively investigated with respect to demographic parameters and sedation conditions. Multivariate logistic analyses were conducted for patients with an SpO₂ <90% and a recovery period of >60 minutes to identify the risk factors for poor sedation conditions. A significant odds ratio related to decreased SpO₂ was observed for age, sex, midazolam and propofol levels, concurrent use of nitrous oxide, cerebral palsy, Down syndrome, and mental retardation. The most problematic patients were those diagnosed with Down syndrome (odds ratio, 3.003-7.978; 95% confidence interval; P < .001). Decision tree analysis showed an increased risk of decreased SpO₂ in males with Down syndrome or after administration of >0.493 mg/kg propofol in combination with midazolam. An increased risk of delayed awakening was seen in patients aged less than 21 years and in males administered >0.032 mg/kg of midazolam. Intravenous sedation for dental patients with disabilities, particularly those with cerebral palsy, Down syndrome, or mental retardation, increases the risk of decreased SpO₂. In addition, delayed recovery is expected after midazolam administration.

[PMID: 24423418](#) [PubMed - in process] [PMCID: PMC3891456](#) [Available on 2014/6/1]

21. J Pediatr. 2014 Jan 10. pii: S0022-3476(13)01505-9. doi: 10.1016/j.jpeds.2013.11.070. [Epub ahead of print]

Developmental Trajectories of Mobility and Self-Care Capabilities in Young Children with Cerebral Palsy.

Ketelaar M1, Gorter JW2, Westers P3, Hanna S4, Verhoef M5.

OBJECTIVE: To describe development of mobility and self-care capabilities in young children (aged 1-4 years) with cerebral palsy, and to examine whether the development of mobility and self-care capabilities differs by cerebral palsy severity in terms of 5 distinct Gross Motor Function Classification System (GMFCS) levels. **STUDY DESIGN:** This prospective longitudinal cohort study included 100 children with cerebral palsy (aged 1.5 or 2.5 years at baseline) and their parents. Mobility and self-care capabilities were assessed by the Pediatric Evaluation of Disability Inventory during yearly assessments from inclusion up to age 4.5 years. Longitudinal data for 92 children were available for analysis. Repeated-measures analyses with random coefficient analysis were performed using linear mixed models. **RESULTS:** Despite large variations among individuals in the development of mobility and self-care capabilities in young children with cerebral palsy, distinct developmental trajectories were found for children in different GMFCS levels. The estimated change per month differed significantly by GMFCS level for both outcomes. **CONCLUSIONS:** This longitudinal study provides an evidence base for prognosis in daily mobility and self-care skills in young children with cerebral palsy. The developmental trajectories for GMFCS levels can be helpful in communication between professionals and also in discussions of expectations and goal setting with families regarding mobility and self-care in the daily life of young children with cerebral palsy in neonatal follow-up and pediatric practice.

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22. Sleep Med. 2013 Dec 13. pii: S1389-9457(13)01205-7. doi: 10.1016/j.sleep.2013.08.793. [Epub ahead of print]

Sleep disorders in children with cerebral palsy: neurodevelopmental and behavioral correlates.

Romeo DM1, Brogna C1, Quintiliani M1, Baranello G2, Pagliano E2, Casalino T2, Sacco A1, Ricci D1, Mallardi M1, Musto E1, Sivo S1, Cota F3, Battaglia D1, Bruni O4, Mercuri E5.

OBJECTIVES: We aimed to estimate the frequency of sleep disorders in children with cerebral palsy (CP) using the Sleep Disturbance Scale for Children (SDSC) and to evaluate the relations between sleep disorders and motor, cognitive, and behavioral problems. **METHODS:** One hundred and sixty-five children with CP ages 6-16years (mean age, 11years) were assessed using the SDSC, the Gross Motor Function Classification System (GMFCS), the Wechsler Intelligence Scale for Children and the Child Behavior Check List (CBCL) to assess sleep, motor, cognitive, and behavioral problems, respectively. **RESULTS:** An abnormal total sleep score was found in 19% of children with CP; more than 40% of children had an abnormal score on at least one SDSC factor. The SDSC total score was significantly associated ($P<.01$) with mental retardation, epilepsy, CBCL scores, and level 5 on the GMFCS. **CONCLUSIONS:** Our results confirm that sleep disorders are common in children with cerebral palsy. The relationship between motor and cognitive behavior and epilepsy should be further explored to better understand how these factors influence one another to identify effective treatments and to improve the well-being of the child.

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23. *J Bodyw Mov Ther.* 2014 Jan;18(1):62-7. doi: 10.1016/j.jbmt.2013.05.009. Epub 2013 Jul 24.

Effect of a hyperbolide mastication apparatus for the treatment of severe sleep bruxism in a child with cerebral palsy: Long-term follow-up.

Giannasi LC1, Freitas Batista SR2, Matsui MY2, Hardt CT2, Gomes CP2, Oliveira Amorim JB2, Oliveira CS3, de Oliveira LV4, Gomes MF2.

PURPOSE: Sleep bruxism is common among the various oromotor alterations found in individuals with cerebral palsy (CP). Few studies have investigated the use of the mastication device denominated "hyperbola" (HB) and none was found describing the use of such a device for the treatment of bruxism in children with CP. The aim of the present study was to evaluate the effect of the HB on electromyographic (EMG) activity in the jaw-closing muscles and the reduction in sleep bruxism in a child with CP using surface EMG analysis before and after nine months of treatment. **METHODS:** A seven-year-old boy with severe spastic CP and sleep bruxism was enrolled in this study. The HB was chosen as the treatment option for sleep bruxism in this case because the child did not accept an occlusal splint. The HB has a hyperbolic shape and is made of soft, non-toxic, odorless, tasteless silicone. There are five different sizes of HB manufactured based on the diversity of tooth sizes. This device produces proprioceptive excitation in the dentoalveolar nerve, spindles and Golgi tendon organs. HB has been employed for the treatment of temporomandibular disorder, abnormal oro-dental development, abnormal occlusion, xerostomy, halitosis and bruxism. HB therapy was performed for 5 min six times a day over a nine-week period. Surface EMG of the mandible at rest and during maximum contraction was performed on the masseter and temporalis muscles bilaterally to evaluate electromyographic activity before and after nine months of HB usage. **RESULTS:** HB usage led to a visible tendency toward the reorganization of mastication dynamics, achieving a marked balance in electromyographic activity of the jaw-closing muscles and improving the child's quality of life. **CONCLUSION:** Based on the findings of the present study, this noninvasive therapy may be useful for individuals with cerebral palsy due to its positive effects and low cost, which allows its use in the public health realm. Further clinical studies with a larger sample size are needed to validate these results and allow the development of a new treatment protocol for patients with spastic cerebral palsy.

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24. *J Laparoendosc Adv Surg Tech A.* 2014 Jan 11. [Epub ahead of print]

Laparoscopic Redo Nissen Fundoplication After Previous Open Antireflux Surgery in Infants and Children.

Cheng AW, Shaul DB, Lau ST, Sydorak RM.

Recurrent gastroesophageal reflux is a common complication after fundoplication procedures. We report our experience with laparoscopic redo Nissen fundoplications in pediatric patients with a history of open antireflux procedure. The medical records of all patients with a history of open antireflux procedure who underwent a subsequent laparoscopic redo Nissen fundoplication were reviewed. One hundred eighty laparoscopic Nissen fundoplications were performed between September 2004 and September 2012; 23 were redo procedures. Twelve patients had a history of prior open fundoplication. Average time between operations was 113.7±64 months. Seven patients presented with emesis, 4 with aspiration pneumonia, and 1 with clinical reflux. Eight had a history of cerebral palsy and/or seizure disorder. Laparoscopic revision was completed in 100% of the patients, with no intraoperative complications. Average operative time was 177.5±86 minutes. Seven patients were able to resume feeds on postoperative Day 1. Median length of stay was 3 days. Median follow-up was 21 months. One patient required a redo antireflux procedure 8 months later for persistent dysphagia. Thus laparoscopic revision Nissen fundoplication after a prior open antireflux procedure is feasible and safe.

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25. BMC Neurosci. 2014 Jan 11;15(1):10. doi: 10.1186/1471-2202-15-10.

Differences in somatosensory processing due to dominant hemispheric motor impairment in cerebral palsy.

Riquelme I, Padrón I, Cifre I, González-Roldán AM, Montoya P.

BACKGROUND: Although cerebral palsy (CP) is usually defined as a group of permanent motor disorders due to non-progressive disturbances in the developing fetal or infant brain, recent research has shown that CP individuals are also characterized by altered somatosensory perception, increased pain and abnormal activation of cortical somatosensory areas. The present study was aimed to examine hemispheric differences on somatosensory brain processing in individuals with bilateral CP and lateralized motor impairments compared with healthy controls. Nine CP individuals with left-dominant motor impairments (LMI) (age range 5-28 yrs), nine CP individuals with right-dominant motor impairments (RMI) (age range 7-29 yrs), and 12 healthy controls (age range 5-30 yrs) participated in the study. Proprioception, touch and pain thresholds, as well as somatosensory evoked potentials (SEP) elicited by tactile stimulation of right and left lips and thumbs were compared. **RESULTS:** Pain sensitivity was higher, and lip stimulation elicited greater beta power and more symmetrical SEP amplitudes in individuals with CP than in healthy controls. In addition, although there was no significant differences between individuals with RMI and LMI on pain or touch sensitivity, lip and thumb stimulation elicited smaller beta power and more symmetrical SEP amplitudes in individuals with LMI than with RMI. **CONCLUSIONS:** Our data revealed that brain processing of somatosensory stimulation was abnormal in CP individuals. Moreover, this processing was different depending if they presented right- or left-dominant motor impairments, suggesting that different mechanisms of sensorimotor reorganization should be involved in CP depending on dominant side of motor impairment.

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26. Eur J Paediatr Neurol. 2013 Dec 25. pii: S1090-3798(13)00206-7. doi: 10.1016/j.ejpn.2013.12.003. [Epub ahead of print]

European study of frequency of participation of adolescents with and without cerebral palsy.

Michelsen SI1, Flachs EM2, Damsgaard MT2, Parkes J3, Parkinson K4, Rapp M5, Arnaud C6, Nystrand M7, Colver A4, Fauconnier J8, Dickinson HO4, Marcelli M9, Uldall P10.

Children with cerebral palsy participate less in everyday activities than children in the general populations. During adolescence, rapid physical and psychological changes occur which may be more difficult for adolescents with impairments. Within the European SPARCLE project we measured frequency of participation of adolescents with cerebral palsy by administering the Questionnaire of Young People's Participation to 667 adolescents with cerebral palsy or their parents from nine European regions and to 4666 adolescents from the corresponding general populations. Domains and single items were analysed using respectively linear and logistic regression. Adolescents with cerebral palsy spent less time with friends and had less autonomy in their daily life than adolescents in the general populations. Adolescents with cerebral palsy participated much less in sport but played electronic games at least as often as adolescents in the general populations. Severity of motor and intellectual impairment had a significant impact on frequency of participation, the more severely impaired being more disadvantaged. Adolescents with an only slight impairment participated in some domains as often as adolescents in the general populations. Regional variation existed. For example adolescents with cerebral palsy in central Italy were most disadvantaged according to decisional autonomy, while adolescents with cerebral palsy in east Denmark and northern England played sports as often as their general populations. Participation is an important health outcome. Personal and environmental predictors of participation of adolescents with cerebral palsy need to be identified in order to design interventions directed to such predictors; and in order to inform the content of services.

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27. Dev Med Child Neurol. 2014 Jan 16. doi: 10.1111/dmcn.12377. [Epub ahead of print]**School readiness of children with cerebral palsy.**

Gehrmann FE, Coleman A, Weir KA, Ware RS, Boyd RN.

AIM: To examine school readiness in preschool-age children with cerebral palsy (CP) on three of five domains compared with reported norms of children with typical development (CTD). **ETHOD:** A representative population of 151 preschool-age children with CP (87 males, 64 females; 131 [87%] with spasticity, 17 [11%] dyskinesia, 3 [4%] hypotonia) were assessed at 48 or 60 months corrected age. Children were functioning in the following Gross Motor Function Classification System (GMFCS) levels: I, 74 (49%); II, 17 (11%); III, 14 (9%); IV, 26 (17%); V, 20 (13%). Children's motor performance, self-care, and social function were assessed using the Pediatric Evaluation of Disability Inventory (PEDI) and communication using the Communication and Symbolic Behaviour Scales Developmental Profile (CSBS-DP). Results were compared with a reference sample of CTD (PEDI CTD n=412; CSBS-DP CTD n=790). Linear regression was used to compare these data by functional severity. **RESULTS:** Children with CP had significantly lower PEDI scores in all domains than CTD. Self-care scores ranged from 0.5 to more than 4SD below CTD, motor performance was 2 to >4SD below CTD, and social function between 0.5 and >4SD below CTD. Fifty-five per cent of children demonstrated significantly delayed communication skills. Non-ambulant children displayed significantly lower scores than ambulant children. **INTERPRETATION:** Preschool-age children with CP perform significantly below their peers in three of five key readiness-to-learn skill areas including mobility, self-care, social function, and communication abilities. Broader emphasis needs to be placed on multimodal screening and intervention to prepare children with CP for school entry.

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28. Scand J Occup Ther. 2014 Jan 13. [Epub ahead of print]**Evaluating intervention using time aids in children with disabilities.**

Janeslätt G, Kottorp A, Granlund M.

Objective: The aim of this study was to evaluate complex intervention using time aids for children with intellectual and developmental disabilities who exhibit limitations in daily time management. **Methods:** Participating children (n = 47) (F17/M30) were aged 6-11 with ADHD, autism spectrum disorders, mild or moderate intellectual disability, spina bifida, and cerebral palsy. This study used a Randomized Block and Waiting List control group design, with 25 children allocated to control and 22 to intervention group. In total 10 children (21.3%), five from each group, dropped out, leaving 37 children in the data analysis. **Results:** Children in both groups gained significantly in time-processing ability between the first and second data collection, but the children in the intervention group improved time-processing ability significantly more than controls. The control group also displayed significant changes after receiving intervention between the second and third data collection. The intervention had a large effect (ES Cohen's d = 0.81) on time-processing ability and a medium effect (ES Cohen's d = 0.68) on managing one's time. **Conclusions:** This study provides preliminary evidence that time-processing ability and managing one's time can be improved by intervention using time aids in children with intellectual and developmental disabilities, supporting the need to consider time aids in intervention in these children.

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Prevention and Cure

29. *Dev Med Child Neurol.* 2014 Feb;56(2):178-84. doi: 10.1111/dmcn.12331. Epub 2013 Nov 8.

An Australian population study of factors associated with MRI patterns in cerebral palsy.

Reid SM, Dagia CD, Ditchfield MR, Carlin JB, Meehan EM, Reddihough DS.

AIM: The aim of this study was to describe the distribution of magnetic resonance imaging (MRI) patterns in a large population sample of children with cerebral palsy (CP) and to examine associations between MRI patterns, and antenatal and perinatal variables. **METHOD:** Data were retrieved from the Victorian CP Register for 884 children (527 males, 357 females) born between 1999 and 2006. Postneonatal MRI was classified for 594 children. For 563 children (329 males, 234 females) for whom classification was to a single MRI pattern, the frequency of each variable was compared between patterns and with the population frequency. **RESULTS:** White matter injury was the most common MRI pattern (45%), followed by grey matter injury (14%), normal imaging (13%), malformations (10%), focal vascular insults (9%), and miscellaneous patterns (7%). Parity, birth gestation, level of neonatal care, Apgar score, and time to established respiration varied between MRI patterns ($p < 0.01$). Nulliparity was most strongly associated with focal vascular insults, whereas multiparity was associated only with malformations. Grey matter injury was not associated with birth in a tertiary unit, but was strongly associated with severe perinatal compromise. The frequency of neonatal seizures and of nursery admissions was lowest among children with malformations. **INTERPRETATION:** As known risk factors for CP are differentially associated with specific MRI patterns, future exploration of causal pathways might be facilitated when performed in pathogenically defined groups.

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30. *Eur J Paediatr Neurol.* 2014 Jan 2. pii: S1090-3798(13)00210-9. doi: 10.1016/j.ejpn.2013.12.005. [Epub ahead of print]

Chorioamnionitis and cerebral palsy: Lessons from a patient registry.

Shevell A1, Wintermark P2, Benini R1, Shevell M3, Oskoui M4.

AIM: The fetal neuroinflammatory response has been linked to the development of brain injury in newborns and subsequent neurologic impairment. We aimed to explore the maternal and child factors associated with histologic chorioamnionitis in cerebral palsy. **METHODS:** We conducted an observational study on a cohort of children with cerebral palsy who were identified from the Quebec Cerebral Palsy Registry. Placental pathology was reported prospectively. Maternal and child factors associated with histological chorioamnionitis were explored. **RESULTS:** Placental reports were available in 455 of 534 (85%) children with cerebral palsy, and of these 12% had histological signs of chorioamnionitis on reports. These children were more likely to have large placentas over 90th percentile for gestational age (53.7% versus 30.7%, $p = 0.001$) and were born significantly more prematurely (<32 weeks in 51.9% vs 24.1%, $p = 0.007$) than children without chorioamnionitis. A clinical sign of perinatal infection was reported in 61.1% of children with chorioamnionitis, however each clinical sign was seen in a minority of these children. Children with chorioamnionitis were more likely to have spastic diplegic cerebral palsy subtype (37% vs 19.2%, $p = 0.003$) and periventricular white matter injury on neuroimaging (52.9% vs 35.8%, $p = 0.004$). However no differences in neuroimaging or subtypes were seen when stratified by prematurity. **DISCUSSION:** Histological chorioamnionitis was a frequent pathological finding in children with cerebral palsy born prematurely, with larger placentas relative to gestation and birth weight. Future case control studies are needed to shed light on the role of inflammatory placental findings in pregnancy outcomes.

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31. J Obstet Gynaecol India. 2013 Apr;63(2):108-11. doi: 10.1007/s13224-012-0251-8. Epub 2012 Sep 27.

Cerebrovascular complications in pregnancy and puerperium.

Prabhu TR.

OBJECTIVES: The aim of this study was to analyze the incidence, possible etiological factors, pathology, clinical manifestations, brain CT scan features, treatment, and prognosis of cerebrovascular complications occurring in pregnancy and puerperium. **METHODOLOGY:** This is a prospective analytical study conducted at the Govt. Hospital for women and children, Chennai, from January 2006 to February 2008. During the above period, 26 women were diagnosed with various cerebrovascular complications. In these patients, the clinical data, risk factors, neurological features, investigations, results, and neuroimaging reports were analyzed. **RESULTS:** The incidence of cerebrovascular complications in this study was 66 per 100,000 deliveries. None had prior history of diabetes, hypertension, renal disease, or seizure disorder. Two women were suffering from cardiac disease. PET and eclampsia were seen in 19/26 (73 %) cases. Seven women were suffering from anemia and one with severe sepsis. The neurological complications manifested predominantly in the postpartum period. Cases presented with hemiplegia/ facial palsy and aphasia. CT scan imaging showed intracerebral hemorrhage in four cases, cerebral infarcts in five cases, and cortical vein thrombosis in 16 cases. There were five maternal deaths in this study. **CONCLUSION:** Stroke occurring in pregnancy, though rare, is a serious complication which can lead to maternal death. In this study, hypertension has emerged as an important risk factor; therefore, attention should be focussed on maintaining normotension in the peripartum period.

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32. J Child Neurol. 2014 Jan 10. [Epub ahead of print]

Neurometabolic Disorder With Microcephaly, Dystonia, and Central Cyanosis Masquerading as Cerebral Palsy.

Devadathan K, Sreedharan M, Sarasam S, Colah RB, Kunju PA.

Many neurodegenerative diseases can be misdiagnosed as cerebral palsy. The correct diagnosis is reached when the condition recurs in families or when there are specific clinical signs. The clinical and imaging features of 3 children, from 2 unrelated families, presenting with global developmental delay and dystonia are described, in whom the presence of cyanosis and methemoglobinemia confirmed the diagnosis of recessive hereditary methemoglobinemia type 2. Magnetic resonance imaging showed significant cerebellar atrophy in 2 of the 3 babies. In dark-skinned children, this condition is underdiagnosed, as mild cyanosis is difficult to detect. Screening for methemoglobinemia in children with dystonia, microcephaly, and progressive cerebellar atrophy can be helpful in identifying more cases. As there is no curative treatment for this autosomal recessive condition, the exact diagnosis offers the best chance for prenatal screening, by detecting deficient NADH - cytochrome b5 reductase enzyme activity or by identifying the specific mutation in cultured amniotic fluid cells.

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