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## Interventions and Management

### 1. Evaluation of Risk Factors for Cerebrospinal Leakage in Pediatric Patients With Cerebral Palsy Treated With Intrathecal Baclofen

Ahmet Imerci, Kenneth J Rogers, Freeman Miller, Julieanne P Sees

J Pediatr Orthop. 2020 Jul;40(6):e522-e526. doi: 10.1097/BPO.0000000000001472.

**Background:** Insertion of an intrathecal baclofen (ITB) pump can provide significant benefits in patients with cerebral palsy (CP). However, there are little data describing the risk of complications. Specifically, there is a lack of data describing the incidence of cerebrospinal fluid (CSF) leakage and risk factors following ITB placement. The purpose of our study was to describe risk factors for developing CSF leak in pediatric patients with CP treated with ITB and to report the treatment and outcome of CSF leaks. **Methods:** Following institutional review board approval, 720 ITB procedures in 341 children with CP were identified retrospectively over a 15-year study period. Patients' demographic characteristics, medical comorbidities, muscle tone patterns, feeding tube status, seizure history, inpatient events, ITB-related CSF leak and headache complaints and their management, and other complications were evaluated. **Results:** Eighty-five (24.9%) patients experienced 90 CSF leak episodes over a follow-up time of 6.3±3.9 years. There were 72 episodes of headache as a result of CSF leakage in 61 (71.7%) of these 85 patients. There was a positive correlation between the risk of CSF leak and preoperative comorbidities such as epilepsy/seizure history, feeding tube, mixed type CP, and dystonic type CP. The risk of CSF leak after primary ITB administration was 5.8% (20/341), and the risk after secondary ITB procedures due to complications was 24.2% (32/132). There was no significant relationship between CSF leak and primary ITB ( $P=0.21$ ), but the risk of CSF leak was positively correlated to the secondary ITB due to complications ( $P<0.05$ ). **Conclusions:** CSF leak was fairly common (25% incidence), and it correlated with epilepsy/seizure history, feeding tube, mixed type CP, and dystonic type CP. Recurrent ITB procedures were a risk factor for CSF leak. Half of these patients had self-limited symptoms that improved with conservative medical treatment, and the epidural blood patch was successful in resistant cases. Successful treatment of CSF leakage complications allows patients to continue ITB. Level of evidence: Level III.

PMID: [32501926](https://pubmed.ncbi.nlm.nih.gov/32501926/)

### 2. Structured Observation of Motor Performance in Infants: Level and Quality Associate to Later Motor Development

Cecilia Montgomery, Ylva Fredriksson Kaul, Katarina Strand Brodd, Kristina Persson, Lena Hellström-Westas

Acta Paediatr. 2020 May 31. doi: 10.1111/apa.15377. Online ahead of print.

**Aim:** The aim of this study was to investigate the level of motor development and the quality of motor performance during the first 10 months in relation to the Bayley Scales of Infant Development-third edition (Bayley-III) motor index at 2.5 years. **Methods:** Children born very preterm from a population-based study ( $n=113$ ) were assessed with the Structured Observation of Motor Performance in-Infants (SOMP-I) at 2, 4, 6 and 10 months corrected age and the Bayley-III motor index at 2.5 years

corrected age (n=98). Logistic regressions were performed to investigate the independent association of each SOMP-I domain to Bayley-III motor index. Results: There were significant associations between the SOMP-I-scores and Bayley-III motor index per every assessment age. At 4 months, both level and quality were independently associated to a later motor outcome, OR for level was 1.26 (95% CI= 1.08-1.50, p=0.002) and for quality, 0.75 (95% CI= 0.63-0.90, p=0.002). Quality was independently associated to the Bayley-III motor index at 6 and 10 months: OR 0.080 (95% CI=0.67-0.95 p=0.010) and 0.79 (95% CI=0.64-0.97, p=0.026). Conclusion: Both SOMP-I domains, level and quality, are markers to identify motor problems early. Quality became more important with age.

PMID: [32474945](#)

### **3. Pre-operative Gastrocnemius Lengths in Gait Predict Outcomes Following Gastrocnemius Lengthening Surgery in Children With Cerebral Palsy**

Apoorva Rajagopal, Łukasz Kidziński, Alec S McGlaughlin, Jennifer L Hicks, Scott L Delp, Michael H Schwartz

PLoS One. 2020 Jun 5;15(6):e0233706. doi: 10.1371/journal.pone.0233706. eCollection 2020.

Equinus deformity is one of the most common gait deformities in children with cerebral palsy. We examined whether estimates of gastrocnemius length in gait could identify limbs likely to have short-term and long-term improvements in ankle kinematics following gastrocnemius lengthening surgery to correct equinus. We retrospectively analyzed data of 891 limbs that underwent a single-event multi-level surgery (SEMLS), and categorized outcomes based on the normalcy of ankle kinematics. Limbs with short gastrocnemius lengths that received a gastrocnemius lengthening surgery as part of a SEMLS (case limbs) were 2.2 times more likely than overtreated limbs (i.e., limbs who did not have short lengths, but still received a lengthening surgery) to have a good surgical outcome at the follow-up gait visit (good outcome rate of 71% vs. 33%). Case limbs were 1.2 times more likely than control limbs (i.e., limbs that had short gastrocnemius lengths but no lengthening surgery) to have a good outcome (71% vs. 59%). Three-fourths of the case limbs with a good outcome at the follow-up gait visit maintained this outcome over time, compared to only one-half of the overtreated limbs. Our results caution against over-prescription of gastrocnemius lengthening surgery and suggest gastrocnemius lengths can be used to identify good surgical candidates.

PMID: [32502157](#)

### **4. Improved Clinical and Functional Outcomes in Crouch Gait Following Minimally Invasive Hamstring Lengthening and Serial Casting in Children With Cerebral Palsy**

Jason T Long, Leah Cobb, Micah C Garcia, James J McCarthy

J Pediatr Orthop. 2020 Jul;40(6):e510-e515. doi: 10.1097/BPO.0000000000001437.

Background: Serial extension casting represents a novel solution for addressing residual knee flexion contractures following hamstring lengthening in children with cerebral palsy. The purpose of this study was to investigate postoperative changes in patients following hamstring lengthening with a serial casting protocol. Methods: Measures from preoperative and postoperative gait analyses were reviewed retrospectively for 19 patients with cerebral palsy who underwent hamstring lengthening followed by serial extension casting. Postoperative changes in clinical, functional, and kinematic parameters were assessed using paired parametric methods. Results: Improvements were measured in popliteal angle, knee contracture, peak stance phase knee extension, sagittal plane range of motion of the knee during walking, Gait Deviation Index, and pediatric outcomes data collection instrument Global score. Nearly 80% of the cohort (15/19 patients) demonstrated a significant or moderate response to the intervention, whereas 20% demonstrated no improvement. Of note, significantly increased anterior pelvic tilt was also observed. Conclusions: Hamstring lengthening combined with a serial casting protocol was associated with significant postoperative improvements in a range of clinical (eg, knee contracture), functional (eg, pediatric outcomes data collection instrument Global), and kinematic (eg, knee extension in stance) parameters. Improvements following this minimally invasive surgery were comparable to outcomes from procedures with higher complication rates. Level of evidence: This is a Level III Therapeutic Study (retrospective study investigating the results of a treatment).

PMID: [32501924](#)

### **5. Using the Edinburgh Visual Gait Score to Compare Ankle-Foot Orthoses, Sensorimotor Orthoses and Barefoot Gait**

**Pattern in Children With Cerebral Palsy**

Clare MacFarlane, Wayne Hing, Robin Orr

Children (Basel). 2020 Jun 1;7(6):E54. doi: 10.3390/children7060054.

Gait analysis is one aspect of evaluation in ambulatory children with cerebral palsy (CP). Ankle-foot orthoses (AFOs) improve gait and alignment through providing support. An alternative and under-researched orthosis are sensomotoric orthoses (SMotOs). The Edinburgh Visual Gait Score (EVGS) is a valid observational gait analysis scale to measure gait quality. The aim of this study was to use the EVGS to determine what effect AFOs and SMotOs have on gait in children with CP. The inclusion criteria were: mobilizing children with a CP diagnosis, no surgery in the past six weeks, and currently using SMotOs and AFOs. Eleven participants were videoed walking 5 m (any order) barefoot, in SMotOs and AFOs. Of the participants (age range 3-13 years, mean  $5.5 \pm 2.9$ ), two were female and six used assistive devices. Seven could walk barefoot. Participants had spastic diplegia (4), spastic quadriplegia (6), and spastic dystonic quadriplegia (1). Gross Motor Functional Classification System (GMFCS) levels ranged I-IV. The total score for SMotOs (7.62) and AFOs (14.18) demonstrated improved gait when wearing SMotOs (no significant differences between barefoot and AFOs). SMotOs may be a viable option to improve gait in this population. Additional study is required but SMotOs may be useful in clinical settings.

PMID: [32492892](#)**6. Factors Affecting GDI Improvement After Single Event Multilevel Surgery in Patients With Cerebral Palsy**

Jae Jung Min, Soon-Sun Kwon, Ki Hyuk Sung, Kyoung Min Lee, Chin Youb Chung, Moon Seok Park

Gait Posture. 2020 May 25;80:101-105. doi: 10.1016/j.gaitpost.2020.05.033. Online ahead of print.

Background: Pathologic gait is common in patients with cerebral palsy (CP). Single-event multilevel surgery (SEMLS) is a combination of surgical procedures to improve pathologic gait in patients with CP. However, the effect of each procedure is difficult to predict. The gait deviation index (GDI) is useful in comparing pre- and postoperative improvement. Research question: In this study, we evaluated the degree of GDI improvement in patients with CP and analyzed factors related to surgical outcomes. Methods: We screened patients seen between May 2003 and December 2019 via a clinical data warehouse to identify those with CP who had been followed up for >1 year and who had undergone SEMLS. The inclusion criteria were (1) CP patients with GMFCS levels I, II and III, (2) patients who underwent SEMLS, (3) and patients who underwent 3D gait analyses preoperatively and at least 1 year postoperatively. A linear mixed model was used to model GDI improvement, assess effects of covariates, and examine factors that contributed to improvement. Results: Overall, 544 patients were included. The average improvement in overall GDI was  $8.9 \pm 12.3$ ,  $9.6 \pm 12.0$ , and  $6.4 \pm 8.6$  in Gross Motor Function Classification System (GMFCS) levels I, II, and III, respectively. In GMFCS level II patients, GDI improvement decreased by 0.26 points with a 1-year delay in surgery ( $p = 0.0022$ ). Within each group of GMFCS levels, femoral derotation osteotomy (FDO) was a significant factor in GDI improvement in GMFCS levels I and II. Rectus femoris transfer (RFT) and supracondylar extension osteotomy (SCO) were significant factors in GMFCS level II. No single procedure was shown to affect improvement in GMFCS level III. Significance: Postoperative GDI improved in all levels of GMFCS. Particular procedures especially affected postoperative improvement in GDI in levels I and II. Our data do not mean to set an indication for particular procedures; however, in GMFCS levels I, II patients, particular procedures, such as FDO, yielded a greater GDI improvement in our data set.

PMID: [32497978](#)**7. Association of Knee Pain and Crouch Gait in Individuals With Cerebral Palsy**

Eliza Pelrine, Tom Novacheck, Elizabeth Boyer

J Pediatr Orthop. 2020 Jul;40(6):e504-e509. doi: 10.1097/BPO.0000000000001487.

Background: Crouch gait (ie, excessive knee flexion) is commonly seen in patients with cerebral palsy (CP) and has been inconsistently linked with knee pain. The definitive cause of knee pain is unknown, but may result from increased joint forces due to crouch gait kinematics. Our purpose was to determine whether knee pain is positively associated with knee flexion in gait among a large sample of ambulatory individuals with CP. We hypothesized that knee pain prevalence would increase as knee flexion increased. Methods: In this retrospective study, pain questionnaire and 3-dimensional gait analysis data from 2015

to 2018 were extracted from the medical records of individuals with CP who had a clinical gait analysis. The pain questionnaire asked caregivers/patients to indicate the location of pain and when it occurs. A multivariate logistic regression was performed with minimum knee flexion in stance, patella alta, age, and sex as predictors of knee pain. Results: Among the 729 participants included in the analysis, 147 reported knee pain (20.1%). The odds of knee pain were not associated with minimum knee flexion in stance or sex. However, the odds of knee pain increased 73.2% when patella alta was present ( $P=0.008$ ) and tended to increase 2.2% as age increased ( $P=0.059$ ). Conclusions: The data suggest that there is not a meaningful association between crouch gait and knee pain. Having patella alta was associated with pain. Further studies that use validated pain questionnaires are needed to understand the multifactorial etiology of knee pain within ambulatory individuals with CP. Level of evidence: Level III-case-control study.

PMID: [32501923](#)

## 8. What's New in the Orthopaedic Treatment of Ambulatory Children With Cerebral Palsy Using Gait Analysis

Julianne P Sees, Walter H Truong, Tom F Novacheck, Freeman Miller, Andrew G Georgiadis

J Pediatr Orthop. 2020 Jul;40(6):e498-e503. doi: 10.1097/BPO.0000000000001461.

Background: Limb deformities in ambulatory children with cerebral palsy (CP) are common. The natural history of lower extremity deformities is variable and the impact on gait is managed with many treatment modalities. Effective interventions must consider the underlying pathophysiology, patient-specific goals, and incorporate objective outcome assessment. Evaluation and treatment include observation, tone management multilevel orthopaedic surgery to address muscle contractures and bony deformities, and the use of gait analysis for preoperative and postoperative assessment. Methods: A PubMed search of the orthopaedic literature for studies published between January 2016 and February 2019 was performed. Eligible abstracts included the use of 3-dimensional instrumented gait analysis in the evaluation and treatment of the lower extremities in ambulatory children with CP. Seven hundred twenty abstracts were reviewed, with 84 papers identified as eligible, of which 45 full manuscripts were included for detailed review. Results: The review summarized recent advances regarding the treatment of torsional alignment, knee deformities and clinical gait evaluation with visual assessment tools compared with instrumented gait analysis. Conclusions: Gait analysis of ambulatory children with CP remains essential to evaluation and surgical decision-making. Promising results have been reported with the goal of maintaining or reaching a higher level of function and increased endurance. Level of evidence: Level IV-literature review.

PMID: [32501922](#)

## 9. Muscle Activity in Children With Spastic Unilateral Cerebral Palsy When Walking With Ankle-Foot Orthoses: An Explorative Study

Lærke Lindskov, Ann-Britt Huse, Marie Johansson, Ståle Nygård

Gait Posture. 2020 May 23;80:31-36. doi: 10.1016/j.gaitpost.2020.05.011. Online ahead of print.

Background: A hinged ankle-foot orthosis is prescribed for children with spastic unilateral cerebral palsy to improve gait function by correcting spastic equinus. However, little is known about how orthotic management relates to muscle activity during walking in this population. Research question: Does muscle activity in medial gastrocnemius and tibialis anterior change in children with spastic unilateral cerebral palsy when walking with hinged ankle-foot orthoses featuring two different footplate designs? Methods: In this prospective, repeated-measures trial, electromyographic activity in medial gastrocnemius and tibialis anterior was recorded from 17 children (mean age: 8.4 years  $\pm$  1.3 years) with spastic unilateral cerebral palsy walking barefoot and with two designs of hinged ankle-foot orthosis. The orthotic devices consisted of custom-made hinged ankle-foot orthoses with unmodified, flatter footplates and rectified, contoured footplates. Primary outcome measures were total muscle activity, quantified as the area under a linear envelope, and relative change in profiles of muscle activity, depicted by curves of mean difference with 95% confidence bands. Results: No statistical difference was found in total activity of either muscle for the ankle-foot orthosis with an unmodified footplate but a significant reduction in muscle activity of tibialis anterior was seen for the ankle-foot orthosis with a contoured footplate relative to barefoot walking. Profiles of change in muscle activity were significantly altered for both shank muscles between all walking conditions. The most pronounced differences were decreased activity in medial gastrocnemius during early stance phase and lower activity in tibialis anterior during swing phase with orthotic devices. Significance: Orthotic management with hinged ankle-foot orthoses may mitigate spastic activation of medial gastrocnemius in children with spastic unilateral cerebral palsy but also appears to functionally inactivate tibialis anterior during gait. The hinged ankle-foot orthosis with an unmodified footplate corresponded with better performance

by facilitating more functional muscle activity while impeding spastic response.

PMID: [32485421](#)

### **10. Use of Shear Wave Elastography for Quantitative Assessment of Muscle Stiffness After Botulinum Toxin Injection in Children With Cerebral Palsy**

Huseyin Bertan, Julide Oncu, Ersin Vanli, Kerem Alptekin, Ali Sahillioglu, Banu Kuran, Figen Yilmaz

J Ultrasound Med. 2020 Jun 3. doi: 10.1002/jum.15342. Online ahead of print.

**Objectives:** This study aimed to investigate the stiffness of the gastrocnemius (GC) muscle with acoustic radiation force impulse (ARFI) elastography after botulinum toxin-A (BTX-A) injection in children with spastic cerebral palsy (CP) and to examine the relationship between elastographic and clinical parameters. **Methods:** This prospective randomized single-blind controlled clinical study included 49 lower extremities of 33 children with spastic CP. They were randomized into 2 groups: group 1 (n = 25 extremities in 17 children) received BTX-A injection and a home-based exercise program; group 2 (n = 24 extremities in 16 children) received only a home-based exercise program. Patients were evaluated in pretreatment and posttreatment periods in the first and third months with ARFI elastography, the Modified Ashworth Scale, Modified Tardieu Scale, Pediatric Functional Independence Measure, Gross Motor Function Classification System, and goniometric range of motion measurement of the ankle. **Results:** A statistically significant difference was found in elastography of the GC muscle in group 1 only at the first month after treatment ( $P < .05$ ). No statistical difference was found in elastography of the GC after treatment in group 2. According to the Modified Ashworth Scale, Modified Tardieu Scale, and ankle passive range of motion, group 1 showed significant improvements after treatment ( $P < .05$ ). Also, there was a significant correlation between these clinical parameters and elastographic measurements ( $P < .05$ ). **Conclusions:** According to the results of this study, the measurements from ARFI elastography combined with clinical parameters might be useful for evaluation of spasticity after BTX-A treatment in children with CP. Also, they might be useful in distinguishing patients who will benefit clinically, especially in the early stages of treatment.

PMID: [32488891](#)

### **11. Pilot Evaluation of a School-Based Programme Focused on Activity, Fitness, and Function Among Children With Cerebral Palsy at GMFCS Level IV: Single-Subject Research Design**

Carol Daly, Connie L Moore, Suzanne Johannes, Julie Middleton, Lisa K Kenyon

Physiother Can. Spring 2020;72(2):195-204. doi: 10.3138/ptc-2018-0053.

**Purpose:** Children with cerebral palsy (CP) who function at Gross Motor Function Classification System (GMFCS) Level IV have difficulty achieving sufficient levels of physical activity to promote fitness. The purpose of this pilot evaluation was to investigate the practicability and impact of a school-based supported physical activity programme, using adaptive bicycles, on cardiorespiratory fitness and gross motor function among children with CP at GMFCS Level IV. **Method:** We used a single-subject, A-B-A-B research design replicated across three participants aged 8-14 years with CP at GMFCS Level IV who attended three different schools. Cardiorespiratory fitness was assessed weekly during all study phases using the energy expenditure index (EEI). Gross motor function was assessed using the Gross Motor Function Measure-66 (GMFM-66) and goal attainment scaling (GAS). During the intervention phases, an adaptive bicycle-riding programme was carried out daily at school for up to 30 minutes. **Results:** One participant demonstrated significant improvement on the EEI. All participants demonstrated improvement in gross motor function as determined by the GMFM-66 and GAS. Insights were garnered pertaining to the design for large-scale future studies. **Conclusions:** This pilot evaluation supports further investigation of school-based adaptive bicycle-riding programmes for children who have CP at GMFCS Level IV.

PMID: [32494103](#)

### **12. A 10-year Retrospective Review of Botulinum Toxin Injections and Surgical Management of Sialorrhea**

Rachel E Weitzman, Kosuke Kawai, Roger Nuss, Amy Hughes

Cureus. 2020 May 1;12(5):e7916. doi: 10.7759/cureus.7916.

**Background** Sialorrhea is a common comorbidity among children with neurologic disorders. Botulinum toxin injections and surgical procedures are recommended for the management of pathological sialorrhea in patients who fail conservative management or with concerns for salivary aspiration. The following review evaluates outcomes following botulinum toxin injections and surgical interventions for sialorrhea over a 10-year period with a focus on treatment options and outcomes for patients with anterior and posterior drooling. **Methods** The study included all patients less than 25 years of age who underwent a procedure for drooling (Current Procedural Terminology (CPT) codes 42440, 42450, 42509, 42510, 64611 matched with the International Classification of Diseases (ICD)-9 and ICD-10 codes 527.7 and K11.7) from January 1, 2006 to December 31, 2015. A chart review collected demographics, drooling medication use, and type of drooling (anterior, posterior, both). **Outcome variables** included pre- and post-procedure number of bibs, parent-reported outcomes, post-intervention drooling medication requirement, post-procedure length of stay, and complications. **Results** Seventy-one patients were included in our analysis, with 88 total procedures performed. The average age at first intervention was 8.9 years; 43 patients were male and 40 patients had cerebral palsy. Thirty-one patients experienced posterior drooling or anterior/posterior drooling. These patients were more likely to undergo surgery as the first invasive intervention. The most commonly performed interventions were botulinum toxin injections (28 patients, 39%) and sublingual gland excision (SLGE) with submandibular duct ligation (SMDL) (36 patients, 51%). Improvement following injections was noted in 56% of patients versus 73% of patients following any surgical intervention. **Conclusion** Management of drooling is complex with 18 different procedures performed over 10 years. Surgical interventions, specifically SLGE with SMDL and submandibular gland excision (SMGE), result in substantial improvement; these are commonly performed as the first intervention in patients with posterior drooling. By reviewing our experience, we hope to guide management decisions and help manage patient and caregiver expectations.

PMID: [32494530](#)

### **13. Effectiveness of Different Parenting Interventions on Oral Hygiene of Cerebral Palsy Children: A Randomized Controlled Trial**

Vedha Vpk, Vikrant R Mohanty, Aswini Y Balappanavar, Monica Juneja, Vaibhav Gupta, Shivam Kapoor

Spec Care Dentist. 2020 Jun 2. doi: 10.1111/scd.12481. Online ahead of print.

**Aim:** To assess the effectiveness of different parenting interventions for improving oral hygiene of cerebral palsy (CP) children aged 4-12 years. **Methodology and results:** A randomized controlled trial was done among 60 CP children and parents visiting a tertiary care center in New Delhi. The study population was randomly assigned to experimental or control group (30 in each group). Parents/caregivers in the experimental group (Group 1) received video-based dental health education (DHE) and the control group (Group 2) received conventional DHE. Each group also received two telephonic reinforcements at fourth and eighth week after the first intervention at baseline. The groups were assessed for sociodemographic, familial factors, medical history, oral hygiene practices, and oral hygiene status. At 3-month follow-up, the mean reduction in simplified oral hygiene index (OHI-S), plaque index (PI), and gingival index (GI) scores was 0.27, 0.17, and 0.09, respectively, in Group 1 (P-value < .05). The mean reductions seen in Group 2 were 0.03 in OHI-S, 0.14 in PI, and 0.04 in GI index (P-value < .05, except for GI score: P-value = .6). **Conclusion:** Video-based DHE is effective and brings about significant improvement in oral hygiene status and oral health among CP children.

PMID: [32488889](#)

### **14. Inequalities in Treatment Planning for Children With Intellectual Disabilities: A Questionnaire Study of Dentists in Europe**

Ariane Camoin, Corinne Tardieu, Lionel Dany, Bérengère Saliba-Serre, Denise Faulks, Pierre Le Coz

Spec Care Dentist. 2020 Jun 2. doi: 10.1111/scd.12482. Online ahead of print.

**Background:** Children with intellectual disabilities experience major inequality in the field of oral health, including a higher number of extracted teeth. The literature explains this difference in terms of higher levels of dental disease but does not mention the possibility of inequality in the treatment options offered these children. **Aim:** The aim is to investigate whether the same treatment options are offered by practitioners to children with and without intellectual disability in equivalent clinical circumstances. **Design:** A scenario involving a clinical dental situation was developed, with one varying parameter: the patient

described was a child with or without cerebral palsy. Results: One hundred and thirty-nine dental specialists from France and Europe were recruited. A large number of practitioners (68%) chose the same treatment for both patients, but 32% declared modifying the dental treatment planning in the case of the child with cerebral palsy. The most frequently chosen treatment for the scenario of irreversible pulpitis for the child without disability was conservative endodontic treatment (73%) whereas the most frequently chosen treatment for the child with intellectual disability was tooth extraction (54%). Discussion: These results are discussed in terms of beneficence, fear of restorative failure, lack of guidelines, practitioner experience and the implications for equity in healthcare.

PMID: [32488884](#)

### **15. Impact of Pain on Affective Disorders Among Adults With Cerebral Palsy**

Lisa Grandidge, Krishnan Padmakumari Sivaraman Nair

Dev Med Child Neurol. 2020 Jun 2. doi: 10.1111/dmcn.14570. Online ahead of print.

PMID: [32484576](#)

### **16. Documenting Change With the Canadian Occupational Performance Measure for Children With Cerebral Palsy**

Mani Kang, Emma Smith, Charles H Goldsmith, Lauren Switzer, Peter Rosenbaum, Frances Virginia Wright, Darcy Fehlings

Dev Med Child Neurol. 2020 Jun 3. doi: 10.1111/dmcn.14569. Online ahead of print.

**Aim:** To assess the Canadian Occupational Performance Measure's (COPM) ability to document change over 3 years in children with cerebral palsy (CP). **Method:** This was a prospective study with ambulatory children with CP, aged 2 to 6 years. Caregivers set one to three COPM goals which were rescored annually over 3 years. A ceiling effect for performance goals was operationalized as a score of 8. A Wald  $\chi^2$  generalized estimating equations model adjusted for age, sex, and Gross Motor Function Classification System (GMFCS) level, evaluated change over time. **Results:** In total, 124 children (47 [37.9%] females, 77 [62.1%] males; mean age 3y 11mo [SD 1y 1mo]; GMFCS level I [n=78, 62.9%], II [n=21, 16.9%], and III [n=25, 20.2%]) were set 345 COPM goals at baseline. By Year 3, 106 participants (85.5%) rescored 287 of the goals (83.2%). Performance scores increased between baseline mean (SD) 2.93 (0.56), Year 1 5.98 (0.58) with 34.8% at ceiling; Year 2 6.74 (0.60) 48.3% at ceiling; and Year 3 7.37 (0.60) 59.6% at ceiling (Wald  $\chi^2$  [3]=607.18,  $p<0.001$ ). Satisfaction scores increased between baseline 4.42 (0.59), Year 1 6.82 (0.60) with 48% at ceiling; Year 2 7.53 (0.60) with 62.2% at ceiling (Wald  $\chi^2$  [3] =208.48,  $p<0.001$ ); with no significant increase by Year 3 7.82 (0.62) with 66.9% at ceiling. **Interpretation:** COPM performance scores increased steadily over 3 years. By Year 2, a ceiling effect was seen in about half of the goals. The COPM may have utility to measure change over 3 years; periodic resetting of the descriptors of goal success are required to minimize ceiling.

PMID: [32491226](#)

### **17. Eye Gaze Gaming Intervention in Children With Dyskinetic Cerebral Palsy: A Pilot Study of Task Performance and Its Relation With Dystonia and Choreoathetosis**

Saranda Bekteshi, Marco Konings, Inti Vanmechelen, Jan Deklerck, Els Ortibus, Jean-Marie Aerts, Hans Hallez, Petra Karlsson, Bernard Dan, Elegast Monbaliu

Dev Neurorehabil. 2020 Jun 4;1-9. doi: 10.1080/17518423.2020.1770890. Online ahead of print.

**Objectives:** To investigate the operational competences screen navigation and dwell function underlying eye gaze performance, and the relation of dystonia and choreoathetosis with eye gaze performance in children with dyskinetic cerebral palsy (DCP). **Methods:** During a 5-week intervention, ten participants with DCP played eye gaze video games daily for 30 minutes. Six games were used to assess task performance, fixation count, and eye movement accuracy during four measurements. Dystonia and choreoathetosis were evaluated using the Dyskinesia Impairment Scale. **Results:** Eye gaze performance improved over time ( $p = .013$ ). Moderate to strong within-subject correlations were found between eye movement accuracy and task performance,

and between eye movement accuracy and fixation count. No significant correlations were found with the movement disorders. Conclusions: Eye gaze technology shows great potential to be a successful computer interface for children with severe DCP, thereby potentially improving their communication skills, participation levels, and quality of life.

PMID: [32496837](#)

### **18. Development and Validation of a Mobile Application for Measuring Femoral Anteversion in Patients With Cerebral Palsy**

Ki Hyuk Sung, Kibeom Youn, Chin Youb Chung, Muhammad I Kitta, Hendra C Kumara, Jae Jung Min, Jehhee Lee, Moon Seok Park

J Pediatr Orthop. 2020 Jul;40(6):e516-e521. doi: 10.1097/BPO.0000000000001468.

**Background:** Computed tomography (CT) provides benefits for 3-dimensional (3D) visualization of femur deformities. However, the potential adverse effects of radiation exposure have become a concern. Consequently, a biplanar imaging system EOS has been proposed to enable reconstruction of the 3D model of the femur. However, this system requires a calibrated apparatus, the cost of which is high, and the area occupied by it is substantial. The purpose of this study was to develop a mobile application that included a new method of 3D reconstruction of the femur from conventional radiographic images and to evaluate the validity and reliability of mobile the application when measuring femoral anteversion. **Methods:** The statistical shape model, graph-cut algorithm, and iterative Perspective-n-Point algorithm were utilized to develop the application. The anteroposterior and lateral images of a femur can be input using the embedded camera or by file transfer, and the touch interface aids accurate contouring of the femur. Regarding validation, the CT scans and conventional radiographic images of 36 patients with cerebral palsy were used. To evaluate concurrent validity, the femoral anteversion measurements on the images reconstructed from the mobile application were compared with those from the 3D CT images. Three clinicians assessed interobserver reliability. **Results:** The mobile application, which reconstructs the 3D image from conventional radiographs, was successfully developed. Regarding concurrent validity, the correlation coefficient between femoral anteversion measured using 3D CT and the mobile application was 0.968 ( $P < 0.001$ ). In terms of interobserver reliability, the intraclass correlation coefficient among the 3 clinicians was 0.953. **Conclusions:** The measurement of femoral anteversion with the mobile application showed excellent concurrent validity and reliability in patients with cerebral palsy. The proposed mobile application can be used with conventional radiographs and does not require additional apparatus. It can be used as a convenient technique in hospitals that cannot afford a CT machine or an EOS system. **Level of evidence:** Level III-diagnostic.

PMID: [32501925](#)

### **19. The Importance of Communication Classifications in Cerebral Palsy Registers**

Mary Jo Cooley Hidecker

Dev Med Child Neurol. 2020 Jun 2. doi: 10.1111/dmcn.14571. Online ahead of print.

PMID: [32484918](#)

### **20. Fetal Heart Rate Pattern in Term or Near-Term Cerebral Palsy: A Nationwide Cohort Study**

Masahiro Nakao, Asumi Okumura, Junichi Hasegawa, Satoshi Toyokawa, Kiyotake Ichizuka, Naohiro Kanayama, Shoji Satoh, Nanako Tamiya, Akihito Nakai, Keiya Fujimori, Tsugio Maeda, Hideaki Suzuki, Mitsutoshi Iwashita, Tomoaki Ikeda

Am J Obstet Gynecol. 2020 Jun 1;S0002-9378(20)30615-3. doi: 10.1016/j.ajog.2020.05.059. Online ahead of print.

**Background:** It is crucial to interpret the fetal heart rate pattern with a focus on the pattern evolution during labor to estimate the relationship between cerebral palsy and delivery. However, nationwide data are lacking. **Objective:** The aim of our study was to demonstrate the features of fetal heart rate pattern evolution and estimate the timing of fetal brain injury during labor in cerebral palsy cases. **Study design:** In this longitudinal study, 1,069 consecutive intrapartum fetal heart rate strips from infants with severe cerebral palsy at or beyond 34 weeks of gestation were analyzed. They were categorized as (i) continuous



bradycardia (Bradycardia); (ii) persistently non-reassuring (NR-NR); (iii) reassuring-prolonged deceleration (R-PD); (iv) Hon's pattern (R-Hon); and (v) persistently reassuring (R-R). The clinical factors underlying cerebral palsy in each group were assessed. Results: Hypoxic brain injury during labor (R-PD+R-Hon) accounted for 31.5% of severe cases and at least 30% developed during the antenatal period [Bradycardia, 7.86% (n=84); NR-NR, 21.7% (n=232); R-PD, 15.6% (n=167); R-Hon, 15.9% (n=170); R-R, 19.8% (n=212); unclassified, 19.1% (n=204); overall interobserver agreement: moderate (kappa 0.59)]. Placental abruption was the most common cause (31.9%) of cerebral palsy, accounting for almost 90% of cases in the Bradycardia group (n=64/73). Among the cases in the R-Hon group (n=67), umbilical cord abnormalities were the most common clinical factor for cerebral palsy (29.9%), followed by the placental abruption (20.9%) and inappropriate operative vaginal deliveries (13.4%). Conclusion: Intrapartum hypoxic brain injury accounted for approximately 30% of severe cerebral palsy cases, while a substantial proportion of cases were suspected of having either a prenatal or postnatal onset. Up to 16% of cerebral palsy cases may be preventable with a greater focus on the earlier changes seen with Hon's fetal heart rate progression.

PMID: [32497609](#)

## 21. Cerebral Palsy Is a Sensorimotor Disorder

Bernard Dan

Editorial Dev Med Child Neurol. 2020 Jul;62(7):768. doi: 10.1111/dmcn.14542.

PMID: [32484581](#)

## 22. Effect of Intravenous Aminocaproic Acid on Blood Loss and Transfusion Requirements After Bilateral Varus Rotational Osteotomy: A Double-blind, Placebo-controlled Randomized Trial

Ishaan Swarup, Joseph Nguyen, Chris Edmonds, Emily Dodwell, David Scher

J Pediatr Orthop. 2020 Jul;40(6):e454-e459. doi: 10.1097/BPO.0000000000001480.

Background:  $\epsilon$ -Aminocaproic acid (EACA) is an antifibrinolytic agent that has been shown to decrease blood loss and transfusion requirements in several populations undergoing various surgical procedures. However, the efficacy of EACA has not been assessed in pediatric patients with cerebral palsy undergoing bilateral varus rotational femoral osteotomies. The purpose of this study was to assess the efficacy of intravenous EACA in reducing calculated intraoperative blood loss and transfusions in this population. Methods: Patients aged 18 years or younger were eligible. Patients were randomized to receive EACA or placebo (saline), and randomization was stratified based on sex and whether or not additional soft tissue or osseous procedures were performed. On the basis of retrospective data, the calculated sample size was 12 patients per arm to detect a difference of 250-mL blood loss. The primary outcome was calculated intraoperative blood loss. Secondary outcomes included transfusion requirements, 24-hour drain output, length of stay, and incidence of complications. Results: The mean age of patients in this study was 8 years (SD: 2.4 y). There were no differences in age, sex, height, weight, type of anesthesia, operative time, and associated procedures between the EACA and placebo groups ( $P > 0.05$ ). Preoperative hematocrit was lower in the EACA group (37.1 vs. 40.0,  $P = 0.04$ ). Calculated intraoperative blood loss was 536 mL in the EACA group and 628 mL in the placebo group ( $P = 0.45$ ). Transfusions were required in 62% of patients in the EACA group and 67% of patients in the placebo group ( $P = 0.68$ ). Total 24-hour drain output was 72.5 mL in the EACA group and 103.3 mL in the placebo group ( $P = 0.37$ ). Length of stay was similar between both groups, and there were no drug or placebo-related complications in either group. Conclusions: There was no difference in blood loss or transfusion requirements associated with EACA compared with placebo; however, this study is underpowered to detect smaller differences in blood loss. Additional studies with larger sample sizes are needed to confirm these findings and further elucidate the indications for antifibrinolytic agents in pediatric patients. Level of evidence: Level I.

PMID: [32501914](#)

## 23. General Movement Assessment Predicts Neuro-Developmental Outcome in Very Low Birth Weight Infants at Two Years - A Five-Year Observational Study

Fiona Barnes, Lynda Graham, Prakash Loganathan, Vrinda Nair

Indian J Pediatr. 2020 Jun 3. doi: 10.1007/s12098-020-03365-1. Online ahead of print.

**Objective:** To assess the value of general movements (GMs) in predicting the neurodevelopmental outcome using Bayley Scale of Infant Development III (BSID-III) at two years of age in very low birth weight (VLBW) infants. **Methods:** This is a five-year observational study (January 2012-June 2017). Two hundred twenty-seven VLBW infants were assessed in the neurodevelopmental clinic between Jan 2012 and June 2017. Of these 137 infants had GMs assessments at 3 mo post term (first visit to the clinic). **Results:** Absence of fidgety movements (FMs) at 3 mo post term had high specificity and negative predictive value for moderate to severe neurodevelopmental outcome in motor, cognition and language domains (composite score less than 70 in the Bayley III scales of Infant development scores). At 3 mo post term, absent FMs had high sensitivity, specificity and negative predictive value (NPV) for cerebral palsy (CP). **Conclusions:** GMs assessment at 3 mo post term could be considered as an important screening tool for early identification of VLBW infants who are at risk of neurodevelopmental impairment/cerebral palsy.

PMID: [32488806](#)

#### **24. Early Prediction of Adverse Outcomes in Infants With Acute Bilirubin Encephalopathy**

Wenqing Kang, Xiao Yuan, Yaodong Zhang, Juan Song, Falin Xu, Dapeng Liu, Rui Li, Bangli Xu, Wen Li, Yanchao Cheng, Changlian Zhu

Ann Clin Transl Neurol. 2020 Jun 4. doi: 10.1002/acn3.51077. Online ahead of print.

**Objective:** Acute bilirubin encephalopathy (ABE) remains one of the important causes of neonatal mortality and child disability, early identification, and intervention which could improve outcomes. The purpose of this study was to evaluate early predictors of adverse outcomes in infants with ABE. **Methods:** Newborns of gestational age  $\geq 35$  weeks and diagnosed with ABE were included in the study. Bilirubin-induced neurological dysfunction (BIND) score, total serum bilirubin (TSB) peak value, and serum albumin levels were determined. Adverse outcomes were defined as death or survival with auditory dysfunction and/or cerebral palsy. **Results:** Eighty-two infants were eligible for recruitment in the study. The outcome data from 76 ABE infants (92%) were used for analysis, of which 25 infants got adverse outcomes and 51 live a normal life. Univariate analysis for BIND score, TSB peak value, bilirubin-albumin ratio (B/A), albumin level, abnormal AABR, and neonatal sepsis was performed to elucidate the association with adverse outcomes. Bivariate logistic regression analysis showed B/A (OR 10.48, 95%CI: 1.55-70.81,  $P = 0.02$ ) and BIND score (OR 3.68, 95%CI: 1.39-9.72,  $P = 0.01$ ) were correlated with adverse outcomes. ROC curve analysis showed that B/A ( $\geq 8.9$  mg/g), BIND score ( $\geq 6$ ) could predict adverse outcomes of ABE separately; B/A in conjunction with BIND score could increase prediction sensitivity to 100%. **Interpretation:** Both B/A and BIND score can be used to predict adverse outcomes of ABE, and the combination of the two parameters can increase prediction sensitivity significantly.

PMID: [32495505](#)

#### **25. Prediction of Neurodevelopmental Impairment in Congenital Cytomegalovirus Infection by Early Postnatal Magnetic Resonance Imaging**

Kosuke Nishida, Kazumichi Fujioka, Yusuke Sugioka, Shinya Abe, Mariko Ashina, Sachiyo Fukushima, Shohei Ohyama, Toshihiko Ikuta, Kenji Tanimura 4, Hideto Yamada, Kazumoto Iijima, Ichiro Morioka

Neonatology. 2020 Jun 3;1-7. doi: 10.1159/000508218. Online ahead of print.

**Introduction:** Congenital cytomegalovirus infection (CCMVI) may result in neurodevelopmental impairments (NDIs) such as hearing loss, developmental delay, epilepsy, and cerebral palsy. We aimed to investigate the potential for brain magnetic resonance imaging (MRI) to predict NDI in patients with CCMVI. **Methods:** We studied infants with CCMVI who were referred to our hospital from April 2010 to October 2018 and underwent a brain MRI within 3 months since birth. We screened for 6 classic presentations of CCMVI including ventriculomegaly, periventricular cysts, hippocampal dysplasia, cerebellar hypoplasia, migration disorders, and white matter abnormalities. Images were interpreted by a blinded pediatric radiologist. NDI was defined as having a developmental quotient  $< 80$ , hearing dysfunction, blindness, or epilepsy requiring anti-epileptic drugs at approximately 18 months of corrected age. **Results:** The study involved 42 infants with CCMVI (median gestational age 38 weeks, birthweight 2,516 g). At least one abnormal finding was detected in 28 (67%) infants. Abnormal findings consisted of 3 cerebellar hypoplasia (7%), 7 migration disorders (17%), 26 white matter abnormalities (62%), 12 periventricular cysts (28%), 1 hippocampal dysplasia (2%), and 20 ventriculomegaly (48%). Abnormal findings were

significantly more prevalent in infants with clinical symptoms (21/24, 91%) than in those without (7/19, 37%,  $p < 0.01$ ). For NDI prediction, having  $\geq 2$  of ventriculomegaly, periventricular cysts, and white matter abnormality produced the highest Youden index values (0.78). Conclusion: Infants with CCMVI with at least 2 of the abovementioned specific brain image abnormalities may be at high risk of developing NDI.

PMID: [32492677](#)

## 26. Umbilical Cord Arterial Blood Gas Analysis in Term Singleton Pregnancies: A Retrospective Analysis Over 11 Years

Ji Hee Lee, Jihee Jung, Hyea Park, Seo-Yeon Kim, Do Youn Kwon, Suk-Joo Choi, Soo-Young Oh, Cheong-Rae Roh

Obstet Gynecol Sci. 2020 May;63(3):293-304. doi: 10.5468/ogs.2020.63.3.293. Epub 2020 Apr 13.

Objective: Given that the large volume of data on cord arterial blood gas analysis (ABGA) have been rarely addressed in Korean population, we aimed to examine the incidence, associated factors, and neonatal outcomes in cases of low cord pH, and investigate the incidence of cerebral palsy (CP). Methods: From data of all consecutive term singleton pregnancies delivered in our institution from 2006 to 2016 ( $n=15,701$ ), cases with cord ABGA ( $n=14,221$ ) available were included. We collected information on maternal clinical characteristics and delivery outcomes and also examined neonatal and infant outcomes, including neonatal intensive care unit (NICU) admission and CP, in cases with low cord pH, defined as a  $\text{pH} < 7.1$ . Results: Rates of low Apgar scores at 1 minute ( $< 4$ ) and 5 minutes ( $< 7$ ) were 0.6% ( $n=79$ ) and 0.4% ( $n=58$ ), respectively. Rates of cord  $\text{pH} < 7.2$ ,  $< 7.1$ , and  $< 7.0$  were 7.1% ( $n=1,011$ ), 1.1% ( $n=163$ ), and 0.3% ( $n=38$ ), respectively. Among cases with low cord pH, 30.1% ( $n=49/163$ ) were admitted to the NICU and 11.0% ( $n=18/163$ ) required ventilator support. Ultrasonography of the brain was performed in 28.8% ( $n=47/163$ ), with abnormal findings observed in 27.7% ( $n=13/47$ ). Among cases with low cord pH, 1.8% ( $n=3/163$ ) were subsequently diagnosed with CP, including 2 cases of spastic CP and 1 of ataxic CP. Conclusion: Although low cord pH was a relatively frequent finding observed in 1 out of every 87 cases, hypoxic-ischemic encephalopathy-related CP was found in only 1 out of 7,111 term singleton deliveries over 11 years in our institution.

PMID: [32489974](#)

## 27. What Does Cochrane Say About ... Rehabilitation and Cerebral Palsy?

No authors listed

Physiother Can. Spring 2020;72(2):219. doi: 10.3138/ptc-72-2-cochrane.

PMID: [32494105](#)

## 28. Aortic Isthmus Doppler Velocimetry in Fetuses With Intrauterine Growth Restriction: A Literature Review

Mariana Martins Ferraz, Flávia do Vale Araújo, Paulo Roberto Nassar de Carvalho, Renato Augusto Moreira de Sá

Rev Bras Ginecol Obstet. 2020 May;42(5):289-296. doi: 10.1055/s-0040-1710301. Epub 2020 May 29.

Intrauterine growth restriction (IUGR) is associated with poor perinatal prognosis and a higher risk of stillbirth, neonatal death, and cerebral palsy. Its detection and the evaluation of its severity by new Doppler velocimetric parameters, such as aortic isthmus (AoI), are of great relevance for obstetrical practice. The AoI is a vascular segment that represents a point of communication between the right and left fetal circulations. It is considered to be a functional arterial shunt that reflects the relationship between the systemic and cerebral impedances, and has recently been proposed as a tool to detect the status of hemodynamic balance and prognosis of IUGR in fetuses. In the present review, we noticed that in healthy fetuses, the AoI net flow is always antegrade, but in fetuses with IUGR the deterioration of placental function leads to progressive reduction in its flow until it becomes mostly retrograde; this point is associated with a drastic reduction in oxygen delivery to the brain. The more impaired the AoI flow is, the greater is the risk of impairment in the Doppler velocimetry of other vessels; and the alterations of the AoI Doppler seem to precede other indicators of severe hypoxemia. Although there seems to be an association between the presence of retrograde flow in the AoI and the risk of long-term neurologic disability, its role in the prediction of

perinatal morbi-mortality remains unclear. The AoI Doppler seems to be a promising tool in the management of fetuses with IUGR, but more studies are needed to investigate its employment in clinical practice.

PMID: [32483809](#)

## Prevention and Cure

### **29. miR-135b-dependent Down-Regulation of S100B Promotes Neural Stem Cell Differentiation in a Hypoxia/Ischemia-Induced Cerebral Palsy Rat Model**

Linbao Wen, Jingwei Sun, Xiongao Chen, Ruili Du

Am J Physiol Cell Physiol. 2020 Jun 3. doi: 10.1152/ajpcell.00481.2019. Online ahead of print.

Cerebral palsy (CP) is frequently caused by brain injury during pregnancy, delivery or the immediate postnatal period. The differentiation potential of neural stem cell (NSC) makes them effective in restoring injured tissues and organs with minimal risks of side effects. In this study, we identified a novel microRNA-135b (miR-135b) in CP, and investigated its functional role in mediating NSC differentiation. CP models were established in Wistar rats and validated with the Y-maze test. Gain- and loss-of-function experimentation was performed on CP rats. Then NSCs were isolated and the expression patterns of miR-135b and S100B were altered in NSCs. S100B exhibited high expression in hippocampus tissues of CP models, which was targeted by miR-135b. miR-135b elevation or S100B silencing resulted in promoted NSC differentiation, alleviated brain injury and inhibited NSC apoptosis in hippocampus tissues of CP rats. S100B down-regulation targeted by miR-135b over-expression contributed to the inactivation of the signal transducer and activator of transcription-3 (STAT3) pathway, which promoted NSC differentiation and proliferation but inhibited NSC apoptosis. Our results highlight the suppressor role played by miR-135b in CP by inducing NSC differentiation via inactivation of S100B-dependent STAT3 pathway.

PMID: [32491925](#)