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Interventions and Management

1. Evaluation of sitting and standing postural balance in cerebral palsy by center-of-pressure measurement using force plates: comparison with clinical measurements
Dain Shim, Dongho Park, Beomki Yoo, Joong-On Choi, Juntaek Hong, Tae Young Choi, Eun Sook Park, Dong-Wook Rha

Gait Posture. 2021 Nov 20;92:110-115. doi: 10.1016/j.gaitpost.2021.11.024. Online ahead of print.

Background: Center-of-pressure (CoP) measurements have been studied for assessing balance control. While CoP measurements using force plates have been used to assess standing balance in children with cerebral palsy (CP), it has not been assessed in a sitting position, which specifically reflects trunk postural control. Research question: The purpose of this study was to compare CoP measurements using force plates during both standing and sitting trials with the Pediatric Balance Scale (PBS) in children with spastic CP. Methods: We recruited 26 children with spastic CP (7.8 ± 3.4 years, 4-13 years) and used the PBS, a validated evaluation tool that measures static and dynamic balance control. We took CoP measurements using force plates during sitting and standing. For both trials, subjects stayed still for 10 s with their eyes open or closed. We calculated the CoP velocity, mediolateral (ML) and anteroposterior (AP) velocity, and ML and AP displacements of CoP. Results and significance: During standing trials, static PBS standing scores negatively correlated with more AP displacement and velocity than ML displacement and velocity ($p < 0.05$). During sitting trials, dynamic PBS sitting scores negatively correlated with ML displacement and velocity ($p < 0.05$). CoP parameters in the ML direction of the sitting position and CoP parameters in the AP direction of the standing position may better reflect the balance control in children with spastic CP.

PMID: 34839205

2. Recurrent hip instability after hip reconstruction in cerebral palsy children with spastic hip disease
Brian Po-Jung Chen, Mutlu Çobanoğlu, Julieanne P Sees, Kenneth J Rogers, Freeman Miller

J Orthop Sci. 2021 Nov 25;S0949-2658(21)00363-8. doi: 10.1016/j.jos.2021.10.017. Online ahead of print.

Background: Migration percentage (MP) is widely used to evaluate hip stability in children with spastic cerebral palsy (CP). Orthopedic surgeons need more objective information to make a proper hip reconstruction surgical plan and predict the outcome. Methods: Medical records and plain radiographs of children with CP who underwent the hip reconstruction procedure for dysplasia were reviewed retrospectively. Results: In total, 253 operated hips (140 patients; 11.7 ± 3.3 years old) were included in this study. MP at pre-operative (Tpre) was 35.3 ± 22.5%; at immediate follow-up (Tpost) was 5.9 ± 9.5%; at last follow-up (Tfinal) was 9.8 ± 10.8% (4.5 ± 2.3 years post-operative at age 16.3 ± 2.8 years). In hips with Melbourne Cerebral Palsy Hip Classification Scale (MCPHCS) grade 3 (n = 78), around 30-45% had an unsatisfactory outcome at Tpost and Tfinal. However, hips categorized as other grades showed only 2.1-9.1% of unsatisfactory outcome. In less affected hips (pre-operative MP<30%, n = 122), 109 hips (89.3%) had varus derotation osteotomy only, the other 13 hips (10.7%) were

combined with a pelvic osteotomy. In more severely affected hips (pre-operative MP ≥ 30%, n = 131), 26 hips (19.8%) had varus derotation osteotomy only, the other 105 hips (80.2%) were combined with a pelvic osteotomy. Conclusions: Hips with pre-operative MP between 15 and 29% (MCPHCS grades 3) can be a higher risk group of recurrent hip instability after hip reconstruction surgery. Multiple indications beyond MP should be considered when indicating pelvic osteotomy or hip muscle release as combined procedures with varus femoral osteotomy for hip reconstruction in this milder group to achieve a consistent long-term satisfactory outcome.

PMID: 34840012

3. Ultrasound as a diagnostic tool for femoral head containment disorders in children between one and 12 years of age
Josephine Berger-Groch, Nico Maximilian Jandl, Andre Strahl, Ulrich Bechler, Frank Timo Beil, Markus H F Stuecker

J Child Orthop. 2021 Oct 1;15(5):496-502. doi: 10.1302/1863-2548.15.210092.

Purpose: Ultrasound has been used to diagnose hip dysplasia in neonates and to screen until the end of their first year. For older children, femoral head containment disorders such as developmental dysplasia of the hip, Legg-Calvé-Perthes disease or cerebral palsy are usually diagnosed with plain radiographs. The aim of the present study was to evaluate ultrasound in comparison with radiographic imaging in children up to age 12 years and to determine reference values for sonographic containment parameters. Methods: Hip ultrasound and radiographic imaging were acquired on the same day and then compared. As a reference, normal acetabular angle and acetabulum head index were determined on radiographs. Lateral cartilage distance (LCD), lateral head distance (LHD) and femoral head extrusion angle (HA) were measured on ultrasound images. Results: We included 96 patients with 167 healthy hips in the study. A total of 55 patients were female and 41 male. The mean age was 5.2 years (sd 3.3; 1.0 to 11.9). LCDultrasound, LHDultrasound and HAultrasound correlated significantly with radiographic parameters. The following ultrasound values were calculated as limits for impending loss of containment: LCDultrasound ≥ 6.5 mm, LHDultrasound ≥ 3.3 mm and HAultrasound ≥ 27.6°. Conclusion: Ultrasound is a simple, radiation-free diagnostic tool to detect femoral head containment disorders, even in children older than one year. This study provides reference values for hip ultrasound in children up to 12 years. Level of evidence: III.

PMID: 34858537

4. The impact of asymmetry on the radiographical outcomes following hip reconstruction in patients with cerebral palsy
Carlos Pargas, Tanyawat Saisongcroh, Kenneth J Rogers, Julieanne P Sees, Freeman Miller, M Wade Shrader

J Child Orthop. 2021 Oct 1;15(5):510-514. doi: 10.1302/1863-2548.15.210056.

Purpose: The purpose of this study was to evaluate the impact of asymmetric hip dysplasia on the outcome of hip reconstruction in patients with cerebral palsy according to preoperative migration percentage (MP). Methods: This study was institutional review board-approved for retrospective cohort review. From 2008 to 2018, 65 patients met inclusion criteria: Gross Motor Function Scale Classification (GMFSC) III to V with spastic hips (MP > 30%) who underwent bilateral hip reconstruction, with a follow-up > 24 months. Main exclusion criteria: children with associated syndromes or chromosomal disorders. The cohort was subdivided into three groups according to preoperative MP difference between hips: Group A > 50%, group B 20% to 50% and Group C < 20%. Subsequently, the groups were analyzed individually and then compared. The asymmetry of extended abduction of the hip was also evaluated and separated into three groups: no asymmetry (< 20° difference), mild asymmetry (20° to 50° difference) and severe (> 50° difference). Results: In total, 65 patients underwent bilateral bony reconstructive surgery (130 hips). Mean age at surgery was 10.1 years (sd 3.6; 3.6 to 18.4). Mean age at follow-up was 14.7 years (sd 3.8; 8 to 21). Preoperative GMFSC distribution was grade III (four, 6%), IV (15, 23%) and V (46, 71%). In all, 21 symmetric hips (< 20% MP difference) had a preoperative MP difference of 9% and a follow-up MP difference of 18% ($p > 0.05$); 32 had a preoperative MP difference of 34% and a follow-up MP difference of 16% ($p < 0.0001$); 12 had a preoperative MP difference of 80% and a follow-up difference of 6% ($p < 0.0001$). According to pre- and postoperative abduction values, the mean high hip abduction preoperatively was 34° (sd 17°), whereas low hip abduction was 23° (sd 17°). Conclusion: Hips with asymmetrical dysplasia and/or abduction undergoing bilateral reconstructive surgery focused on symmetric abduction, and corrected dysplasia in patients with cerebral palsy has improved symmetry in hip abduction and MP. Obtaining this goal immediately postoperatively is maintained to medium-term follow-up. Level of evidence: IV.

PMID: 34858539

5. Botulinum Toxin a Injection Combined with Radial Extracorporeal Shock Wave Therapy in Children with Spastic Cerebral Palsy: Shear Wave Sonoelastographic Findings in the Medial Gastrocnemius Muscle, Preliminary Study
Dong Rak Kwon, Dae Gil Kwon

Children (Basel). 2021 Nov 17;8(11):1059. doi: 10.3390/children8111059.

Therapeutic strategies to boost the effect of botulinum toxin may lead to some advantages, such as long lasting effects, the injection of lower botulinum toxin dosages, fewer side effects, and lower costs. The aim of this study is to investigate the combined effect of botulinum toxin A (BTA) injection and extracorporeal shock wave therapy (ESWT) for the treatment of spasticity in children with spastic cerebral palsy (CP). Fifteen patients with spastic CP were recruited through a retrospective chart review to clarify what treatment they received. All patients received a BTA injection on gastrocnemius muscle (GCM), and patients in group 1 underwent one ESWT session for the GCM immediately after BTA injection and two consecutive ESWT sessions at weekly intervals. Ankle plantar flexor and the passive range of motion (PROM) of ankle dorsiflexion were measured by a modified Ashworth scale (MAS) before treatment and at 1 and 3 month(s) post-treatment. In group 1, the shear wave velocity (SWV) of GCM was measured. The PROM and MAS in group 1 and 2 before treatment significantly improved at 1 and 3 month(s) after treatment. The change in PROM was significantly different between the two groups at 1 and 3 month (s) after treatment. The SWV before treatment significantly decreased at 1 month and 3 months after treatment in group 1. Our study has shown that the combination of BTA injection and ESWT would be effective at controlling spasticity in children with spastic CP, with sustained improvement at 3 months after treatment.

PMID: 34828772

6. Moderate effect of ankle foot orthosis versus ground reaction ankle foot orthosis on balance in children with diplegic cerebral palsy
Doaa Ahmed Sanad

Prosthet Orthot Int. 2021 Nov 25. doi: 10.1097/PXR.0000000000000060. Online ahead of print.

Background: The children with diplegic cerebral palsy (CP) commonly have abnormal alignment of lower extremities affecting their abilities of keeping balance. Orthoses are one of the many approaches that can be prescribed to improve balance and walking in diplegic children. Objective: This study was conducted to assess the moderate effect of solid ankle foot orthosis (AFO) vs. the ground reaction ankle foot orthosis (GRAFO) on balance in children with diplegic CP. Study design: A randomized controlled trial. Methods: Thirty children with spastic diplegic CP from both genders participated in this study; their ages were between 6 and 9 years. They were divided randomly into two study groups of equal numbers; the first study group A received the regular physical therapy program besides wearing the AFO for successive three months. The second study group B received the regular physical therapy program besides wearing the GRAFO for successive 3 months. All childrens' balance was evaluated before starting the treatment program and after 3 months by using the Biodex balance system (anteroposterior and mediolateral stability indices). Results: There were significant improvement of all stability indices in both groups ($P < 0.05$), with significant difference between groups when comparing post-treatment mean values of the measured indices in favor to study group B ($P < 0.05$). Conclusion: The GRAFO achieved more balance control in children with spastic diplegic CP compared with solid AFO.

PMID: 34840276

7. Quantitative MRI and Clinical Assessment of Muscle Function in Adults With Cerebral Palsy
Christian Svane, Christian Riis Forman, Aqella Rasul, Christian Hammer Nielsen, Jens Bo Nielsen, Jakob Lorentzen

Front Neurol. 2021 Nov 10;12:771375. doi: 10.3389/fneur.2021.771375. eCollection 2021.

Aim: To relate quantitative magnetic resonance imaging (MRI) of ankle plantar flexor muscles to clinical functional tests in adults with cerebral palsy (CP) and neurologically intact (NI) adults. Methods: Eleven adults with CP (aged 41 ± 12, GMFCS level I-II) and 11 NI adults (aged 35 ± 10) participated in this case-control study. We used MRI to assess muscle volume and composition of the triceps surae muscles. We quantified muscle function as maximal voluntary plantarflexion (MVC) torque and countermovement jump (CMJ) height. Results: Compared to NI adults, the MRI intramuscular fat fraction estimate was

significantly higher and MRI muscle volume and functional abilities (MVC and CMJ) significantly lower in adults with CP. In NI adults, but not adults with CP, MRI muscle volume correlated significantly with MVC and CMJ. In adults with CP, the estimate of intramuscular fat levels correlated significantly with jump height in a CMJ. Discussion: This study shows reduced muscle volume and altered muscle composition in adults with CP. Muscle composition appears to provide a better marker than muscle volume of reduced muscle function and impaired performance in this population. Measurements of muscle composition could be used in the assessment of neuromuscular impairments and in the determination of rehabilitation protocols in individuals with neurological disorders.

PMID: 34858318

8. A-GAS: a Probabilistic Approach for Generating Automated Gait Assessment Score for Cerebral Palsy Children
Rishabh Bajpai, Deepak Joshi

IEEE Trans Neural Syst Rehabil Eng. 2021 Nov 30;PP. doi: 10.1109/TNSRE.2021.3131466. Online ahead of print.

Gait disorders in children with cerebral palsy (CP) affect their mental, physical, economic, and social lives. Gait assessment is one of the essential steps of gait management. It has been widely used for clinical decision making and evaluation of different treatment outcomes. However, most of the present methods of gait assessment are subjective, less sensitive to small pathological changes, time-taking and need a great effort of an expert. This work proposes an automated, comprehensive gait assessment score (A-GAS) for gait disorders in CP. Kinematic data of 356 CP and 41 typically developing subjects is used to validate the performance of A-GAS. For the computation of A-GAS, instance abnormality index (AII) and abnormality index (AI) are calculated. AII quantifies gait abnormality of a gait cycle instance, while AI quantifies gait abnormality of a joint angle profile during walking. AII is calculated for all gait cycle instances by performing probabilistic and statistical analyses. Abnormality index (AI) is a weighted sum of AII, computed for each joint angle profile. A-GAS is a weighted sum of AI, calculated for a lower limb. Moreover, a graphical representation of the gait assessment report, including AII, AI, and A-GAS is generated for providing a better depiction of the assessment score. Furthermore, the work compares A-GAS with a present rating-based gait assessment scores to understand fundamental differences. Finally, A-GAS's performance is verified for a high -cost multi-camera set-up using nine joint angle profiles and a low-cost single camera set-up using three joint angle profiles. Results show no significant differences in performance of A-GAS for both the set-ups. Therefore, A-GAS for both the set-ups can be used interchangeably.

PMID: 34847034

9. Effects of Dynamic Suit Orthoses on the Spatio-Temporal Gait Parameters in Children with Cerebral Palsy: A Systematic Review
Natalia Belizón-Bravo, Rita Pilar Romero-Galisteo, Fatima Cano-Bravo, Gloria Gonzalez-Medina, Elena Pinero-Pinto, Carlos Luque-Moreno

Review Children (Basel). 2021 Nov 5;8(11):1016. doi: 10.3390/children8111016.

Dynamic suit orthoses (DSO) are currently used as a complementary treatment method in children with Cerebral Palsy (cwCP). The aim of this review was to assess the effects of interventions with DSO on the altered spatio-temporal gait parameters (STGPs) in cwCP. An electronic search was conducted in the Web of Science, Scopus, PEDro, Cochrane Library, MEDLINE/ PubMed, and CINAHL databases up to July 2021. We included a total of 12 studies, which showed great heterogeneity in terms of design type, sample size, and intervention performed (two employed a Therasuit, three employed the Adeli suit, three employed Theratogs, one employed elastomeric tissue dynamic orthosis, one employed a full-body suit, one employed external belt orthosis, and one employed dynamic orthosis composed of trousers and T-shirt). The Cochrane collaboration's tool and the Checklist for Measuring Study Quality were used to assess the risk of bias and the methodological quality of the studies. It was variable according to the Checklist for Measuring Study Quality, and it oscillated between eight and 23. The studies of higher methodological quality showed significant post-intervention changes in walking speed (which is the most widely evaluated parameter), cadence, stride length, and step length symmetry. Although the evidence is limited, the intervention with DSO combined with a programme of training/physical therapy seems to have positive effects on the STGPs in cwCP, with the functional improvements that it entails. Despite the immediate effect after one session, a number of sessions between 18 and 60 is recommended to obtain optimum results. Future studies should measure all STGPs, and not only the main ones, such as gait speed, in order to draw more accurate conclusions on the functional improvement of gait after the use of this type of intervention.

PMID: 34828729

10. Neuromuscular Electrical Stimulation to Immobilized Lower Extremities Directly Following Orthopaedic Surgery in Three Children with Cerebral Palsy: A Case Series
Kelly Greve, Caroline Colvin

Case Reports Sensors (Basel). 2021 Nov 18;21(22):7661. doi: 10.3390/s21227661.

Cerebral palsy (CP) is a non-progressive, neurological disorder often resulting in secondary musculoskeletal impairments affecting alignment and function which can result in orthopaedic surgery. Neuromuscular electrical stimulation (NMES) is a modality that can be used for rehabilitation; however, NMES immediately following orthopaedic surgery in children with CP using surface electrodes has not been previously reported. The purpose of this case series is to describe the novel use of NMES in the acute rehabilitation phase directly after orthopaedic surgery. This case series included three children with spastic diplegia CP, Gross Motor Function Classification System level II who underwent Single Event Multi-Level orthopaedic Surgery. Each long leg cast contained window cast cut-outs to allow for surface electrode placement for daily NMES intervention to the quadriceps muscles while immobilized. Children were assessed pre- and post-operatively using the Functional Mobility Scale (FMS), Gross Motor Function Measure (GMFM-66), and 6-Minute Walk Test (6MWT). All children demonstrated no adverse effects using NMES intervention and had improvements in the 6MWT. Most children demonstrated gains in the FMS and GMFM-66. Use of NMES through window cast-cuts in a long leg cast is a novel practice approach for delivery of early rehabilitation following lower extremity orthopaedic surgery.

PMID: 34833737

11. Aerobic Responses to FES-Assisted and Volitional Cycling in Children with Cerebral Palsy
Ashwini Sansare, Ann Tokay Harrington, Henry Wright, James Alesi, Ahad Behboodi, Khushboo Verma, Samuel C K Lee

Randomized Controlled Trial Sensors (Basel). 2021 Nov 15;21(22):7590. doi: 10.3390/s21227590.

Recumbent stationary cycling is a potential exercise modality for individuals with cerebral palsy (CP) that lack the postural control needed for upright exercises. Functional electrical stimulation (FES) of lower extremity muscles can help such individuals reach the cycling intensities that are required for aerobic benefits. The aim of this study was to examine the effect of cycling with and without FES assistance to that of a no-intervention control group on the cardiorespiratory fitness of children with CP. Thirty-nine participants were randomized to a FES group that underwent an 8-week FES-assisted cycling program, the volitional group (VOL), who cycled without FES, or a no-intervention control group (CON) (15 FES, 11 VOL, 13 CON). Cadence, peak VO2, and net rise in heart rate were assessed at baseline, end of training, and washout (8-weeks after cessation of training). Latent growth curve modeling was used for analysis. The FES group showed significantly higher cycling cadences than the VOL and CON groups at POST and WO. There were no differences in improvements in the peak VO2 and peak net HR between groups. FES-assisted cycling may help children with CP attain higher cycling cadences and to retain these gains after training cessation. Higher training intensities may be necessary to obtain improvements in peak VO2 and heart rate.

PMID: 34833666

12. Utility of the Intelligibility in Context Scale for Predicting Speech Intelligibility of Children with Cerebral Palsy
Jennifer U Soriano, Abby Olivieri, Katherine C Hustad

Brain Sci. 2021 Nov 20;11(11):1540. doi: 10.3390/brainsci11111540.

The Intelligibility in Context Scale (ICS) is a widely used, efficient tool for describing a child's speech intelligibility. Few studies have explored the relationship between ICS scores and transcription intelligibility scores, which are the gold standard for clinical measurement. This study examined how well ICS composite scores predicted transcription intelligibility scores among children with cerebral palsy (CP), how well individual questions from the ICS differentially predicted transcription intelligibility scores, and how well the ICS composite scores differentiated between children with and without speech motor impairment. Parents of 48 children with CP, who were approximately 13 years of age, completed the ICS. Ninety-six adult naïve listeners provided orthographic transcriptions of children's speech. Transcription intelligibility scores were regressed on ICS composite scores and individual item scores. Dysarthria status was regressed on ICS composite scores. Results indicated

that ICS composite scores were moderately strong predictors of transcription intelligibility scores. One individual ICS item differentially predicted transcription intelligibility scores, and dysarthria severity influenced how well ICS composite scores differentiated between children with and without speech motor impairment. Findings suggest that the ICS has potential clinical utility for children with CP, especially when used with other objective measures of speech intelligibility.

PMID: 34827539

13. Nutritional status and prevalence of dysphagia in cerebral palsy: usefulness of the Eating and Drinking Ability Classification System scale and correlation with the degree of motor impairment according to the Gross Motor Function Classification System
A García Ron, R M González Toboso, M Bote Gascón, M T de Santos, R Vecino, A Bodas Pinedo

Neurologia (Engl Ed). 2021 Nov 23;S2173-5808(21)00180-2. doi: 10.1016/j.nrleng.2019.12.006. Online ahead of print.

Introduction and objectives: Digestive disorders are one of the most common comorbidities among children with cerebral palsy (CP). The aim of this study is to examine the nutritional status of patients with CP, the prevalence of dysphagia by degree of motor impairment, and the impact of digestive disorders on quality of life. Material and methods: We conducted a descriptive, cross-sectional, open-label study of out-patients with CP from a tertiary hospital in the Region of Madrid using a structured interview, classifying dysphagia using the Eating and Drinking Ability Classification System (EDACS). We gathered demographical and anthropometric data, and analysed the correlation between severity of dysphagia and functional status as measured with the Gross Motor Function Classification System (GMFCS). Results: Our sample included 44 patients (65.9% boys), with a mean (standard deviation) age of 9.34 (5) years and a mean BMI of 18.5 (4.9). Forty-three percent presented safety and efficiency limitations (EDACS level > II). Safety and efficiency limitations were associated with more extensive motor involvement (60% had tetraparesis), more varied clinical manifestations (87% had mixed forms) and poorer functional capacity (100% on GMFCS V). The impact on nutritional status increased with higher EDACS and GMFCS scores. Conclusions: This is the first study into the usefulness of the EDACS scale in a representative sample of Spanish children and adolescents with CP. Our findings underscore the importance of screening for dysphagia in these patients, regardless of the level of motor impairment, and the need for early treatment to prevent the potential consequences: malnutrition (impaired growth, micronutrient deficiencies, osteopaenia, etc.), microaspiration, or recurrent infections that may worsen patients' neurological status.

PMID: 34836844

14. Epidemiology of Malnutrition among Children with Cerebral Palsy in Low- and Middle-Income Countries: Findings from the Global LMIC CP Register
Israt Jahan, Mohammad Muhit, Denny Hardianto, Francis Laryea, Samuel Kofi Amponsah, Amir Banjara Chhetri, Hayley Smithers-Sheedy, Sarah McIntyre, Nadia Badawi, Gulam Khandaker

Nutrients. 2021 Oct 20;13(11):3676. doi: 10.3390/nu13113676.

Background: This study aimed to describe the epidemiology of malnutrition among children with cerebral palsy (CP) in low- and middle-income countries (LMICs). Methods: Data from children with confirmed CP aged <18 years registered into the Global LMIC CP Register (GLM CPR) from Bangladesh, Indonesia, Nepal, and Ghana were included. Anthropometric measurements were collected, and nutritional status was determined following the WHO guidelines. Descriptive statistics and adjusted logistic regression were used to describe the nutritional status and identify predictors of malnutrition. Results: Between January 2015 and December 2020, 3619 children with CP were registered into the GLM CPR (median age at assessment: 7.0 years, 39% female). Overall, 72-98% of children from Bangladesh, Indonesia, Nepal, and Ghana had at least one form of undernutrition. The adjusted analysis showed, older age, low maternal education, spastic tri/quadriplegia, and Gross Motor Functional Classification System (GMFCS) levels III-V were significant predictors of underweight and stunting among children with CP in Bangladesh. In Nepal, female children, GMFCS III-V had higher odds of underweight and stunting. In Ghana, low maternal education was significantly associated with underweight, whereas older age and the presence of associated impairments were the significant predictors of stunting among children with CP. Having a GMFCS of III-V increased the odds of being underweight among children in Indonesia; however, no predictors were identified for stunting, as nearly all children with CP registered from Indonesia were stunted. Conclusion: Most children with CP in GLM CPR had undernutrition. Maternal education and moderate-to-severe motor impairment (GMFCS III-V) were significant predictors. Practical nutrition education to mothers/caregivers and management guidelines according to the motor severity using local

resources could improve the nutritional outcome of children with CP in LMICs.

PMID: 34835932

15. Predictors of Range of Motion Restrictions in Children with Spastic Cerebral Palsy: A Registry-Based Study
Nihad A Almasri, Ed J Gracely, Maysoun Saleh, Fatima Alzahra Alquaqzeh

Child Care Health Dev. 2021 Dec 3. doi: 10.1111/cch.12938. Online ahead of print.

Background: Although children with spastic cerebral palsy (CP) commonly present with restricted passive range of motion (PROM) and contractures, knowledge about the child's characteristics that increase the risk of development of restricted PROM is limited. Identifying children who are more likely to develop contractures is important for early detection and the provision of appropriate medical management. This study aims to identify the most commonly restricted PROM of children with spastic CP, and (2) to examine the combined effect of a child's age, gender, gross motor functional classification level, and CP subtype on the development of restricted PROM in children with spastic CP. Methods: The PROM of 233 children diagnosed with CP were extracted from the national registry of CP in Jordan (CPUP-Jordan) in addition to information about children's age, gender, level of Gross Motor Furcation Classification System-Expanded and Revised (GMFCS-E&R), and subtype of CP. The mean age of the participants was 3.73 years (SD= 3.14), 57.5% were males, and 80.3% had bilateral spastic CP. Point biserial correlations were calculated between the PROM and the child's variables. Multiple binary logistic regressions were conducted to identify the predictors of PROM. Results: Hip abduction was the most common restricted PROM (57.9%), whereas the hip extension was the least (2.1%). Children with older ages demonstrated more restrictions in knee extension and ankle dorsiflexion; males demonstrated more restriction in hip abduction than females; children with lower GMFCS-E&R levels had more restrictions in hip internal rotation but fewer restrictions in hip abduction and ankle dorsiflexion; and children with bilateral spastic CP had more restrictions in hip abduction than children with unilateral spastic CP. Conclusions: PROM of the hip, knee, ankle joints of children with spastic CP were predicted by different sets of child characteristics. Implications for health professionals and follow-up registries of children with CP are provided.

PMID: 34859481

16. Prevalence of the need for adaptive seating systems among children with cerebral palsy in Egypt
Mohamed Adel Abdallah, Faten Abdelaziem, Mostafa Soliman

Prosthet Orthot Int. 2021 Nov 25. doi: 10.1097/PXR.0000000000000065. Online ahead of print.

Background: An adaptive seating system is a basic rehabilitation need for children and youth with cerebral palsy (CP) as it supports the structure and function of the musculoskeletal system and can positively affect their activities and participation. Despite the importance of adaptive seating systems, there is limited access to such systems in low-income countries. Objectives: To determine the percentage of children and youth between 4 and 18 years of age with CP in Egypt whose activity level and sitting ability suggest the need for an adaptive seating system. Study design: Observational cross-sectional study. Methods: One hundred ninety-three participants were included after fulfilling the criteria of the Surveillance of Cerebral Palsy of Europe. Their level of activity was assessed by a physical therapist using the Gross Motor Function Classification System (GMFCS), and their sitting ability was evaluated using the Level of Sitting Scale (LSS). Participants were considered to require an adaptive seating system if they scored GMFCS level IV or V and LSS level 1-5 concurrently. Results: Approximately 44% of the study participants were classified as GMFCS level IV or V and LSS level 1-5, suggesting that they were in need of an adaptive seating system. Conclusions: There is a large percentage of children and youth with CP in Egypt who need an adaptive seating system to be integrated into their rehabilitation.

PMID: 34840277

17. Association of Obesity on Outcomes of Hospitalized Patients with Cerebral Palsy
Ché Matthew Harris, Scott Mitchell Wright

South Med J. 2021 Dec;114(12):772-776. doi: 10.14423/SMJ.0000000000001328.

Objective: Among hospitalized adults with cerebral palsy (CP), it is unknown whether obesity is associated with clinical and resource utilization outcomes. We sought to identify the association of obesity on clinical and resource utilization outcomes in this population. Methods: This retrospective cohort study analyzed years 2016 and 2017 of the Nationwide Inpatient Sample database and examined hospitalized adults with CP. Regression analyses were used to evaluate mortality and resource utilization. Results: In total, 154,219 adults with CP were hospitalized. Among them, 13,475 (8.7%) had a secondary diagnosis for obesity. Patients with obesity were older (mean age ± standard error of the mean: 49.9 ± 0.18 versus 44.7 ± 0.18 years, P < 0.01), a greater proportion were female (60.7% vs 43.2%, P < 0.01), and were more likely to be insured by Medicare (65.2% vs 56.2%, P < 0.01). Patients with obesity had higher comorbidity burdens (Charlson comorbidity score ≥ 3: 22.3% vs 9.8%, P < 0.01). Those with obesity had lower mortality rates (1.6% vs 2.4%; P < 0.01). After adjustment for confounders, mortality for patients with obesity remained lower (adjusted odds ratio 0.5, 95% confidence interval [CI] 0.4-0.7, P < 0.01). Hospital charges (adjusted mean difference $2499, 95% CI $6202-$1202, P = 0.18) and length of stay (adjusted mean difference 0.01 days; 95% CI -0.28 to 0.31, P = 0.93) were not significantly different between the groups. Conclusions: Obesity was associated with reduced mortality among adult patients in the hospital who had CP. This finding is consistent with the obesity paradox that has been observed repeatedly in patients with other chronic diseases. Further studies investigating hospitalized patients with CP are needed to corroborate these findings.

PMID: 34853853

18. Analysis of Selected Risk Factors Depending on the Type of Cerebral Palsy
Małgorzata Sadowska, Beata Sarecka-Hujar, Ilona Kopyta

Brain Sci. 2021 Oct 30;11(11):1448. doi: 10.3390/brainsci11111448.

Background: Cerebral palsy (CP) is not a defined, separate disease classification, but a set of etiologically diverse symptoms that change with the child's age. According to the up-to-date definition, CP is a group of permanent but not unchanging disorders of movement and/or posture and motor function, which are due to a nonprogressive interference, lesion, or abnormality of the developing/immature brain. CP is one of the most frequent causes of motor disability in children. The aim of the present study was to analyze whether selected risk factors may vary depending on particular types of CP. Methods: 181 children with CP (aged 4-17 years), hospitalized at the Department of Pediatrics and Developmental Age Neurology in Katowice in the years 2008-2016 were retrospectively analyzed in the present study. The assumed risk factors of CP were divided into two groups: 1-pre-conception and prenatal (mother's age, family history of epilepsy, burdened obstetric history, mother's systemic diseases, pregnancy order, multiple pregnancy, duration of pregnancy, bleedings from the genital tract during gestation, arterial hypertension during pregnancy, infections during pregnancy, preterm contractions, maintained pregnancy, premature rupture of membranes, abruptio placentae, and others), 2-perinatal and postnatal (mode of delivery, birth weight, Apgar score at the first and fifth minute, neonatal convulsions, respiratory failure, infections in neonatal and infant period, and intraventricular bleeding). The division into particular CP types was based on Ingram's classification. Results: The following risk factors were the most frequent in the total group: respiratory failure, infections, intraventricular bleeding, and prematurity. Among the analyzed preconception and prenatal factors, the duration of pregnancy and preterm contractions during pregnancy significantly differentiated the subgroups of patients depending on the type of CP. The prevalence of almost all analyzed perinatal, neonatal, and infant-related risk factors (i.e., birth weight, Apgar score at the first and fifth minute, neonatal convulsions, respiratory failure, infections in neonatal and infant period, and intraventricular bleeding) significantly differed between CP types, apart from the mode of delivery. However, in multivariate regression, only intraventricular bleeding was an independent predictor for tetraplegic CP type when compared to joined extrapyramidal and ataxic types (OR = 2.801, p = 0.028). Conclusions: As CP is a syndrome of multifactorial etiology, the identification of CP risk factors entails the need for careful observation and comprehensive care of children in the risk group. The presence of certain risk factors may be a prognostic indicator for particular types of CP. The knowledge about the association between the risk factor(s) and the CP type could be a very useful tool for pediatricians looking after the child at risk of developmental disorders.

PMID: 34827447

19. An Emerging Role for Epigenetics in Cerebral Palsy
Brigette Romero, Karyn G Robinson, Mona Batish, Robert E Akins

Review J Pers Med. 2021 Nov 12;11(11):1187. doi: 10.3390/jpm11111187.

Cerebral palsy is a set of common, severe, motor disabilities categorized by a static, nondegenerative encephalopathy arising in the developing brain and associated with deficits in movement, posture, and activity. Spastic CP, which is the most common type, involves high muscle tone and is associated with altered muscle function including poor muscle growth and contracture, increased extracellular matrix deposition, microanatomic disruption, musculoskeletal deformities, weakness, and difficult movement control. These muscle-related manifestations of CP are major causes of progressive debilitation and frequently require intensive surgical and therapeutic intervention to control. Current clinical approaches involve sophisticated consideration of biomechanics, radiologic assessments, and movement analyses, but outcomes remain difficult to predict. There is a need for more precise and personalized approaches involving omics technologies, data science, and advanced analytics. An improved understanding of muscle involvement in spastic CP is needed. Unfortunately, the fundamental mechanisms and molecular pathways contributing to altered muscle function in spastic CP are only partially understood. In this review, we outline evidence supporting the emerging hypothesis that epigenetic phenomena play significant roles in musculoskeletal manifestations of CP.

PMID: 34834539

20. Fetal and Maternal Inflammatory Response in the Setting of Maternal Intrapartum Fever with and without Clinical and Histological Chorioamnionitis

Sylvie Lagodka, Samantha Petrucci, Michael L Mortti, Michael Cabbad, Nisha A Lakhi

Am J Obstet Gynecol MFM. 2021 Nov 30;100539. doi: 10.1016/j.ajogmf.2021.100539. Online ahead of print.

Background: Both infectious and noninfectious causes of maternal fever have been linked to adverse neonatal outcomes including low Apgar scores, respiratory distress, hypotonia, and neonatal seizures. Even in the absence of infection, the occurrence of intrapartum fever is a strong risk factor for long-term neonatal developmental outcomes, including encephalopathy, cerebral palsy, and neonatal death. Objective: The primary objective of this study was to compare intrapartum and postpartum maternal and fetal umbilical cord serum levels of RANTES, IFN-ɣ, IL-1 beta, IL-2, IL-4, IL-6, IL-8, IL-10, IL-13, and TNF-α between non-febrile patients, febrile patients without clinical chorioamnionitis, and febrile patient with clinical chorioamnionitis. Study design: This study was conducted at Richmond University Medical Center from May 15, 2020-July 16, 2019. During this time, we recruited 30 non-febrile patients >36 gestational weeks who were in labor and collected umbilical cord, maternal pre- and post-delivery serum samples evaluated for cytokine levels. Placentas were collected for pathological review and histopathological findings. These results were compared to 121 patients who developed a fever greater than 38 Celsius during labor. The febrile patients were further divided based on the presence or absence of clinical chorioamnionitis. Secondary analysis was performed based on presence of absence of histological chorioamnionitis. Statistical analysis was performed using IBM SPSS 25.0. For the three group comparisons, a p-value of <0.017 was considered statistically significant after application of a Bonferroni correction. Results: A total of 151 patients were included in the study; 30 nonfebrile patients, 46 febrile patients with a diagnosis of clinical chorioamnionitis, and 75 febrile patients without clinical chorioamnionitis. Compared to nonfebrile patients, umbilical cord levels IFN-γ, IL-1β, IL-6, IL-8, RANTES, and TNF-α were elevated in the presence of maternal hyperthermia regardless of the diagnosis of clinical chorioamnionitis. IL-6 cord levels were more than doubled from 63.60 pg/ml (6.09- 1769.03) in febrile patients with no clinical chorioamnionitis to 135.77 pg/ml (1.86- 6004.78) in febrile patients with clinical chorioamnionitis, making it the only cytokine that was significantly different between these two groups. When comparing intrapartum maternal serum, we found significant elevation IL-10, RANTES, and TNF-α levels in the febrile group regardless of the presence of clinical chorioamnionitis compared to the nonfebrile group. In postpartum maternal blood evaluations, TNF-α was the single cytokine that was significantly higher in febrile patients compared to nonfebrile controls. Conclusion: In the setting of intrapartum fever, maternal cytokine profiles were similar irrespective of the diagnosis of clinical chorioamnionitis. Even in the absence of clinical or histological chorioamnionitis, maternal hyperthermia induced elevations in fetal cytokines.

PMID: 34861429

21. Intrauterine Viral Infections: Impact of Inflammation on Fetal Neurodevelopment

Sourav Ganguli, Pavithra L Chavali

Review Front Neurosci. 2021 Nov 10;15:771557. doi: 10.3389/fnins.2021.771557. eCollection 2021.

Intrauterine viral infections during pregnancy by pathogens such as Zika virus, Cytomegalovirus, Rubella and Herpes Simplex virus can lead to prenatal as well as postnatal neurodevelopmental disorders. Although maternal viral infections are common

during pregnancy, viruses rarely penetrate the trophoblast. When they do cross, viruses can cause adverse congenital health conditions for the fetus. In this context, maternal inflammatory responses to these neurotropic pathogens play a significant role in negatively affecting neurodevelopment. For instance, intrauterine inflammation poses an increased risk of neurodevelopmental disorders such as microcephaly, schizophrenia, autism spectrum disorder, cerebral palsy and epilepsy. Severe inflammatory responses have been linked to stillbirths, preterm births, abortions and microcephaly. In this review, we discuss the mechanistic basis of how immune system shapes the landscape of the brain and how different neurotropic viral pathogens evoke inflammatory responses. Finally, we list the consequences of neuroinflammation on fetal brain development and discuss directions for future research and intervention strategies.

PMID: 34858132

22. It's time for a better definition of neonatal metabolic acidosis!
C Racinet, P Ouellet, T Daboval

Arch Pediatr. 2021 Nov 29;S0929-693X(21)00209-8. doi: 10.1016/j.arcped.2021.10.007. Online ahead of print.

PMID: 34857453

23. Outcomes in very low birthweight infants with severe congenital heart defect following cardiac surgery within the first year of life
Vinzenz Boos, Felix Berger, Mi-Young Cho, Joachim Photiadis, Christoph Bührer, Constanze Pfitzer

Eur J Cardiothorac Surg. 2021 Nov 24;ezab494. doi: 10.1093/ejcts/ezab494. Online ahead of print.

Objectives: Very low birthweight (<1500 g, VLBW) infants with severe congenital heart defect (CHD) are at increased risk for perinatal and operative mortality. This study aims to describe morbidity, long-term mortality and neuro-developmental outcome in early childhood in VLBW infants who received cardiac surgery for severe CHD within 1 year after birth. Methods: Monocentric observational study on VLBW infants with severe CHD born between 2008 and 2017. Neurodevelopmental impairment at 2 years corrected age was defined as cognitive deficit, cerebral palsy or major neurosensory deficit. Results: A total of 24 patients were included. Twenty-one (87.5%) infants underwent cardiac surgery with hypothermia during cardiopulmonary bypass (median temperature 30.3°C, interquartile range 27.0-32.0°C) at a median age of 96 (40-188) days. Seven (29.2%, 95% confidence interval 14.9-49.2%) patients died within the first year after cardiac surgery. Survival rates decreased with increasing STAT mortality category of the surgical procedure. Neurodevelopmental impairment at 2 years of corrected age was found in 9 out of 17 (52.9%) surviving infants, with 8 infants (47.1%) presenting with a cognitive deficit or delay and 4 infants (23.5%) being diagnosed with cerebral palsy. Survival without neuro-developmental impairment was 29.2% (n = 7, 95% confidence interval 14.9-49.2%) in the entire study cohort. Eighty percent of the newborns with dextro-transposition of the great arteries, but no patient with univentricular anatomy, survived without neuro-developmental impairment. Conclusions: Individual VLBW infants with severe CHD may develop well despite the high combined risk for adverse outcomes. The type of cardiac malformation may affect early- and long-term outcomes.

PMID: 34849670

24. Telerehabilitation and Wellbeing Experience in Children with Special Needs during the COVID-19 Pandemic
Daniela Sarti, Marinella De Salvatore, Emanuela Pagliano, Elisa Granocchio, Daniela Traficante, Elisabetta Lombardi

Children (Basel). 2021 Nov 1;8(11):988. doi: 10.3390/children8110988.

Social distancing due to the COVID-19 pandemic represented a golden opportunity to implement telerehabilitation for clinical groups of children. The present study aims to show the impact that telerehabilitation had on the experience of well-being of children with special needs being treated at the Foundation IRCCS Neurological Institute 'C. Besta' in Milan (Specific Learning Disorders and Cerebral Palsy diagnosis); it aims to do so by comparing it with experiences of those who did not undertake telerehabilitation despite the diagnosis during the pandemic, and with typically developing children. Results show that the three

groups differed in the Support, Respect and Learning dimensions of well-being experience. Post hoc comparisons revealed that children with Specific Learning Disorders and Cerebral Palsy scored higher than normotypical children in Support and in Respect scales. Furthermore, children who experienced telerehabilitation showed the highest scores on the Learning scale in comparison with the other two groups. These results support the importance of reorganizing care and assistance by integrating telemedicine, which seems to have fostered a positive experience of well-being in people with special needs, particularly in the perception of a supportive environment that respects psychological needs.

PMID: 34828702

25. The Role of Physiotherapy in Pediatric Palliative Care: A Systematic Review
Silvia Ortiz-Campoy, Cristina Lirio-Romero, Helena Romay-Barrero, David Martín-Caro Álvarez, Purificación López-Muñoz, Rocío Palomo-Carrión

Review Children (Basel). 2021 Nov 12;8(11):1043. doi: 10.3390/children8111043.

Pediatric palliative care (PPC) is a set of actions aimed at children who suffer from a severe or life-threatening disease to alleviate the symptoms of the disease and improve the quality of life of both the child and his/her family. One of the tools used to control symptoms is physiotherapy; however, its application in the child population has not been thoroughly studied. The main objective of this study was to gather, analyze, and critically evaluate the available scientific evidence on physiotherapy in children who require palliative care through a systematic review of the studies published in the last 10 years in the following databases: PubMed, Cochrane Library, PEDro, CINAHL, and Scopus. Of a total of 622 studies, the inclusion criteria were only met by seven articles, which were focused on the relationship between physiotherapy and PPC. This study analyzed: (1) the main pathologies treated, with a predominance of cerebral palsy and cancer; (2) the interventions applied, such as respiratory physiotherapy, neurological physiotherapy, therapeutic massage, and virtual reality; (3) the effects achieved in the child and his/her family, highlighting the control of symptoms and the improvement of the quality of life; and (4) the knowledge of the physiotherapists on PPC, observing that most of the professionals had not received training in this scope. The findings of this review indicate a lack of an adequate evidence foundation for physiotherapy in PPC.

PMID: 34828756

26. Management of Muscle Spasms in Adult Patients with Cerebral Palsy
Samuel Korntner, Catherine Elko, Linda Edwards, Rafik Jacob

South Med J. 2021 Dec;114(12):777-782. doi: 10.14423/SMJ.0000000000001335.

As medical care advances, there is a growing number of adult patients with cerebral palsy. The spastic form is characterized by muscle hypertonicity, hyperreflexia, and spasticity, which are associated with worse quality of life, poor functionality, and pain. This literature review attempts to explore the existing treatments for spasticity in cerebral palsy to provide insight into potential treatments in the adult population. The types of treatments are broadly categorized into physical therapy, pharmacologic treatments, botulinum toxin, surgical treatments, and alternative options.

PMID: 34853854

27. Hemiplegic Cerebral Palsy Complicated by Acute Hemidystonia in Adulthood
Atul Goel, Sunil K Narayan, Ramkumar Sugumaran

Case Reports Neurol Clin Pract. 2021 Oct;11(5):e736-e739. doi: 10.1212/CPJ.0000000000000931.

PMID: 34840893

28. Antenatal magnesium sulphate for preventing cerebral palsy: An economic evaluation of the impact of a quality improvement program

Amy Keir, Alice Rumbold, Emily Shepherd, Sarah McIntyre, Charlotte Groves, Angela Cavallaro, Caroline Crowther, Emily Callander

Aust N Z J Obstet Gynaecol. 2021 Nov 29. doi: 10.1111/ajo.13459. Online ahead of print.

Previous work demonstrated that implementing a quality improvement (QI) program improves the uptake of guideline-recommended antenatal magnesium sulphate, a critical intervention known to reduce cerebral palsy risk. Here we estimate potential cost savings attributable to the improved uptake. By expanding coverage from 63 to 83% of eligible women, we estimated that five children potentially would not have received a diagnosis of cerebral palsy, a potential cost saving of $AU4.8 million in lifetime healthcare costs. Our findings strengthen the case for embedding QI approaches in perinatal care to reduce the incidence of cerebral palsy.

PMID: 34843629