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Interventions and Management

1. Bimanual coordination during a physically coupled task in unilateral spastic cerebral palsy children.

Mutalib SA, Mace M, Burdet E.

J Neuroeng Rehabil. 2019 Jan 3;16(1):1. doi: 10.1186/s12984-018-0454-z.

BACKGROUND: Single object bimanual manipulation, or physically-coupled bimanual tasks, are ubiquitous in daily lives. However, the predominant focus of previous studies has been on uncoupled bimanual actions, where the two hands act independently to manipulate two disconnected objects. In this paper, we explore interlimb coordination among children with unilateral spastic cerebral palsy (USCP), by investigating upper limb motor control during a single object bimanual lifting task. **METHODS:** 15 children with USCP and 17 typically developing (TD) children performed a simple single-object bimanual lifting task. The object was an instrumented cube that can record the contact force on each of its faces alongside estimating its trajectory during a prescribed two-handed lifting motion. The subject's performance was measured in terms of the duration of individual phases, linearity and monotonicity of the grasp-to-load force synergy, interlimb force asymmetry, and movement smoothness. **RESULTS:** Similar to their TD counterparts, USCP subjects were able to produce a linear grasp-to-load force synergy. However, they demonstrated difficulties in producing monotonic forces and generating smooth movements. No impairment of anticipatory control was observed within the USCP subjects. However, our analysis showed that the USCP subjects shifted the weight of the cube onto their more-abled side, potentially to minimise the load on the impaired side, which suggests a developed strategy of compensating for inter-limb asymmetries, such as muscle strength. **CONCLUSION:** Bimanual interaction with a single mutual object has the potential to facilitate anticipation and sequencing of force control in USCP children unlike previous studies which showed deficits during uncoupled bimanual actions. We suggest that this difference could be partly due to the provision of adequate cutaneous and kinaesthetic information gathered from the dynamic exchange of forces between the two hands, mediated through the physical coupling.

PMID: [30606226](#)

2. Effectiveness of Modified Constraint-Induced Movement Therapy Compared With Bimanual Therapy Home Programs for Infants With Hemiplegia: A Randomized Controlled Trial

Chamudot R, Parush S, Rigbi A, Horovitz R, Gross-Tsur V.

American Journal of Occupational Therapy, November 2018, Vol. 72, 7206205010p1-7206205010p9. doi:10.5014/ajot.2018.025981.

OBJECTIVE. We examined the effectiveness of modified constraint-induced movement therapy (mCIMT) in treating infants with hemiplegic cerebral palsy and compared therapy outcomes with a nonconstraining bi-manual therapy (BIM) of equal intensity. **METHOD.** In a single-blinded randomized control led trial, 33 infants with hemiplegia (mean corrected age = 11.1 mo, standard deviation = 2.2) received either mCIMT (n = 17) or BIM (n = 16). Both interventions included home programs

encouraging the use of the affected hand during daily 1-hr play sessions for 8 wk. Outcome measures were administered pre- and posttreatment and included the Mini-Assisting Hand Assessment for babies and the Functional Inventory. At baseline, parents also filled out the Dimensions of Mastery Questionnaire. **RESULTS.** Both groups demonstrated a significantly large and equal improvement in hand and gross motor function posttreatment ($p < .001$) and high treatment compliance. **CONCLUSION.** mCIMT and BIM are equally effective methods for treating infants with hemiplegia.

DOI: [10.5014/ajot.2018.025981](https://doi.org/10.5014/ajot.2018.025981)

3. The effect of interactive computer play on balance and functional abilities in children with moderate cerebral palsy: a pilot randomized study.

Pin TW, Butler PB.

Clin Rehabil. 2019 Jan 2;269215518821714. doi: 10.1177/0269215518821714. [Epub ahead of print]

OBJECTIVES: To investigate the feasibility and potential efficacy of a six-week interactive computer play training on balance and gross motor function in children with moderate cerebral palsy. **DESIGN:** A pilot single-blinded matched randomized controlled study. **SETTING:** Community. **PARTICIPANTS:** In total, 18 children with moderate cerebral palsy were recruited, paired according to age and severity of cerebral palsy and randomized into intervention group or control group. **INTERVENTION:** The intervention group received additional trunk control training using the interactive computer play in sitting four times per week, 20 minutes per session for six weeks. All study children continued their usual physiotherapy programme. **MEASUREMENTS:** All study children were assessed at baseline, week 3, week 6 (completion of intervention) and week 12 using the Pediatric Reach Test, Gross Motor Function Measure-66-Item Set and 2-Minute Walk Test. **RESULTS:** All intervention children completed and enjoyed the training with no reported adverse event. All children were assessed at all time points. No significant difference was found between the two groups in all assessments. In both groups of children, significant improvements were found in the Gross Motor Function Measure-66-Item Set between week 3 (intervention group: mean 53.41, SD 5.34; control group: mean 52.86, SD 8.33) and week 6 (intervention group: mean 55.00, SD 6.32; control group: mean 54.20, SD 8.35). **CONCLUSION:** The intervention protocol of a six-week interactive computer play training was feasible and safe for children with moderate cerebral palsy in special school settings. Future studies with larger sample sizes or using single-subject designs are recommended.

PMID: [30599772](https://pubmed.ncbi.nlm.nih.gov/30599772/)

4. Hip displacement in children with cerebral palsy in Scotland: a total population study.

Bugler KE, Gaston MS, Robb JE.

J Child Orthop. 2018 Dec 1;12(6):635-639. doi: 10.1302/1863-2548.12.180106.

PURPOSE: The purpose of this study is to report the number of children from a total population of children with cerebral palsy (CP) in Scotland who had a displaced or dislocated hip at first registration in a national surveillance programme. **METHODS:** Migration percentage (MP), laterality, Gross Motor Function Classification System (GMFCS) level, CP subtype, distribution of CP and age were analyzed in 1171 children. Relative risk was calculated with 95% confidence intervals. Hip displacement and dislocation were defined as a MP of 40 to 99 and > 100 respectively. **RESULTS:** Radiographs were available from the first assessment of 1171 children out of 1933 children registered on the system. In all, 2.5% of children had either one or both hips dislocated (29/1171) and dislocation only occurred in children of GMFCS levels IV and V. A total of 10% of children had a MP 40 to 99 in one or both hips (117/1171). An increasing GMFCS level was strongly associated with an abnormal MP. Hip dislocation was unusual in patients under the age of seven years. A MP of 40 to 99 was not seen in children with isolated dystonia. Displacement was more frequent in children with bilateral involvement and dislocation was only seen in spastic and mixed tone groups. **CONCLUSION:** This data gives an overview of the number of CP children who have hip displacement/dislocation in Scotland and who will possibly require surgery. **LEVEL OF EVIDENCE:** I.

PMID: [30607212](https://pubmed.ncbi.nlm.nih.gov/30607212/)

5. Kinematic foot types in youth with pes planovalgus secondary to cerebral palsy.

Amene J, Krzak JJ, Kruger KM, Killen L, Graf A, Altiok H, Smith PA, Harris GF.

Gait Posture. 2018 Dec 21;68:430-436. doi: 10.1016/j.gaitpost.2018.12.026. [Epub ahead of print]

BACKGROUND: Kinematic variability of the foot and ankle segments exists during ambulation among individuals with pes planovalgus (PPV) secondary to cerebral palsy (CP). Clinicians have previously recognized such variability through classification schemes to identify subgroups of individuals, but have been unable to identify kinematic foot types. **RESEARCH QUESTION:** The purpose of this work was to identify kinematic foot types among children with PPV secondary to CP using 3-dimensional multi-segment foot and ankle kinematics during gait as inputs for principal component analysis (PCA) and K-means cluster analysis. **METHODS:** In a single assessment session, multi-segment foot and ankle kinematics using the Milwaukee Foot Model (MFM) were collected in 31 children/adolescents with pes planovalgus (49 feet) and 16 typically developing (TD) children/adolescents (31 feet). PCA was used as a data reduction technique on 34 kinematic variables. K-means cluster analysis was performed on the identified principal components (PCs) and one-way analyses of variance (ANOVA) was done to determine the effect of subgroup membership on PC scores. **RESULTS:** The PCA reduced the kinematic variables to seven PCs which accounted for 91% of the total variance. Six distinct kinematic foot types were identified by the cluster analysis. The foot types showed unique kinematic characteristics in both the hindfoot and forefoot. **SIGNIFICANCE:** This study provides further evidence of kinematic variability in the foot and ankle during ambulation associated with pes planovalgus secondary to CP. The specific contributions of the hindfoot and forefoot would not have been detected using a single segment foot model. The identification of kinematic foot types with unique foot and ankle characteristics has the potential to improve treatment since patients within a foot type are likely to benefit from similar intervention(s).

PMID: [30594871](#)

6. Intramuscular injection of collagenase clostridium histolyticum may decrease spastic muscle contracture for children with cerebral palsy.

Howard JJ, Huntley JS, Graham HK, Herzog WL.

Med Hypotheses. 2019 Jan;122:126-128. doi: 10.1016/j.mehy.2018.11.002. Epub 2018 Nov 9.

In cerebral palsy (CP), the spastic motor type is most common, associated with a velocity-dependent increase in muscle stiffness that precedes the development of fixed muscle contracture - a permanent shortening of the muscle tendon unit even when relaxed. Intra-muscular injections of botulinum toxin type A (BTX-A) have become popular for the treatment of spastic muscle contractures but unfortunately its use has not resulted in long-term functional benefits and, paradoxically, has been associated with a persistent loss of contractile material. Recent biomechanical work has shown that the stiffness of the CP muscle increases in proportion to total collagen content within the perimysial extra-cellular matrix. Thus, rather than the use of tone-reducing agents, we hypothesize that the focal use of a selective collagenase, injected into spastic muscle at an appropriate dilution and concentration, may serve to reduce the extent of muscle contracture, improving clinical range of motion and perhaps sarcomere length.

PMID: [30593395](#)

7. [Data analysis of 8 113 cases of limb deformities corrected by external fixation].

Qin S, Guo B, Jiao S, Zang J, Zhang L, Wang Y, Zheng X, Shi L, Qin X.

Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2018 Oct 1;32(10):1241-1248. doi: 10.7507/1002-1892.201807055. [Article in Chinese; Abstract available in Chinese from the publisher]

OBJECTIVE: To analyze the data of external fixation instruments (including Ilizarov instruments) used by QIN Sihe orthopaedic surgical team in the treatment of limb deformities in the past 30 years, and to explore the indications for the application of modern external fixation techniques in the correction of limb deformities and individual device configuration selection strategy. **METHODS:** According to QIN Sihe orthopaedic surgical team, the use of external fixator between January 1988 and December 2017 was analyzed retrospectively. The total use of external fixation and the proportion of different external fixators were analyzed in gender, different operation time, different age, different parts, and different diseases. **RESULTS:** External fixators were used in 8 113 patients, 69 of them were used simultaneously in both lower extremity surgery, so 8 182 external fixators were used. Among them, there were 4 725 (57.74%) combined external fixators, 3 388 (41.41%) Ilizarov circle fixators, 64 (0.78%) single arm external fixators (including Orthofix), 5 (0.06%) Taylor space external fixators. There were 4 487 males (55.31%) and 3 626 females (44.69%). According to the analysis of different time periods, the number of external fixators increased year by year, and the number of applications increased after 2000. The main age of the patients was 11-30 years old, of which 1 819 sets (22.23%) were used at the age of 21-25 years. The use of the external fixator covered almost all parts of the limbs, with the ankle and toe areas being the most common, reaching 4 664 sets (57.00%), and the upper extremities the least, with 152 sets (1.86%). The 8 113 cases covered more than a dozen disciplines and more than 150 kinds of diseases. The top 5 diseases were poliomyelitis sequelae, cerebral palsy, deformity of lower extremity after spina

bifida, traumatic sequelae, and congenital equinovarus foot. CONCLUSION: Ilizarov technique has been widely used in extremity deformity, disability, and complicated orthopedic diseases caused by vascular, lymphoid, nerve, skin, endocrine, and other diseases. The indication of operation is far beyond the scope of orthopedics. The domestic external fixator and its mounting tools can basically meet the requirements of various treatments. The technique of external fixation has entered a new era of tension tissue regeneration under stress control, natural repair of tissue trauma and deformity, and reconstruction of limb function.

PMID: [30600662](#)

8. Developmental Trajectories and Reference Percentiles for Range of Motion, Endurance, and Muscle Strength of Children with Cerebral Palsy.

Jeffries LM, LaForme Fiss A, Westcott McCoy S, Bartlett D, Avery L, Hanna S.

Phys Ther. 2019 Jan 2. doi: 10.1093/ptj/pzy160. [Epub ahead of print]

BACKGROUND: Children with cerebral palsy (CP) frequently present with secondary impairments in spinal alignment and extremity range of motion, endurance for activity, and muscle strength. Creation of developmental trajectories for these impairments will help guide clinical decision-making. **OBJECTIVE:** For children in each level of the Gross Motor Function Classification System (GMFCS) this study aimed to: (1) create longitudinal developmental trajectories for range of motion (Spinal Alignment and Range of Motion Measures (SAROMM)), endurance (Early Activity Scale for Endurance (EASE)), and functional strength (Functional Strength Assessment (FSA)), and (2) develop age-specific reference percentiles and amount of change typical over one-year for these outcomes. **DESIGN:** This study used a longitudinal cohort design. **METHODS:** Seven hundred eight children with CP across GMFCS levels, 18 months up to the 12th birthday and their families participated in 2 to 5 assessments every 6 months over 2 years. Trained therapists performed the SAROMM and FSA, and parents completed the EASE questionnaire. For children in each GMFCS level, longitudinal trajectories using linear and nonlinear mixed-effects models from all visits and reference percentiles using quantile regression from the first, 12-month, and 24-month visits were created for each measure. **RESULTS:** Longitudinal trajectories and percentile graphs for SAROMM, FSA, and EASE are primarily linear, with different performance scores among GMFCS levels. Much variability in both longitudinal trajectories and percentiles exists within GMFCS levels. **LIMITATIONS:** Limitations included a convenience sample and varying numbers of participants assessed at each visit. **CONCLUSIONS:** The longitudinal trajectories and percentile graphs have application for monitoring how children with CP are performing and changing over time compared with other children with CP. The resources presented allow therapists and families to collaboratively make decisions about intervention activities targeted to children's unique needs.

PMID: [30602008](#)

9. Is sensory-level electrical stimulation effective in cerebral palsy children with dysphagia? A randomized controlled clinical trial.

Umay E, Gurcay E, Ozturk EA, Unlu Akyuz E.

Acta Neurol Belg. 2019 Jan 2. doi: 10.1007/s13760-018-01071-6. [Epub ahead of print]

Dysphagia is one of the common findings in children with cerebral palsy (CP). Electrical stimulation (ES) has been demonstrated to positively contribute to swallowing functions, particularly in adult patients with various neurological disorders. Therefore, the objective of this study was to assess the effects of sensory-level ES treatment combined with conventional dysphagia rehabilitation in pediatric age group CP patients who had any oropharyngeal dysphagia symptoms and/or findings. Participants were randomly assigned to either the experimental group (Group 1, n = 52) who underwent intermittent galvanic stimulation to bilateral masseter muscles for 5 days/week, for 4 weeks combined with conventional dysphagia rehabilitation or the control group (Group 2, n = 50) who received sham stimulation with conventional dysphagia rehabilitation. The experimental group achieved significantly more improvement in swallowing functions including drooling, tongue movements, chewing, eating large food ability, feeding duration, as well as dysphagia screen test and dysphagia level, compared to control group. This study suggested that sensory-level ES might be a useful and safe therapeutic modality to improve oropharyngeal symptoms, symptom severity and dysphagia level in children with CP and dysphagia. Further research is needed to determine the long-term effects of ES on dysphagia, especially in different neurological disorders such as CP.

PMID: [30604337](#)

10. A 4-year follow-up case of extrusive luxation in a patient with cerebral palsy.

Véliz Ramírez A, Krämer Strenger S, Solar López M, Muñoz Cortes P, Corral Núñez C.

Spec Care Dentist. 2019 Jan 3. doi: 10.1111/scd.12348. [Epub ahead of print]

Cerebral palsy (CP) is a condition caused by brain damage before, during, or shortly after birth. Communication can be a challenge when treating patients with CP. Some patients can communicate verbally, while others use augmentative alternative communication tools or have individualized means of communication. Therefore, professional dental treatment in individuals with CP is challenging, especially if the patient is affected by dental trauma and requires emergency treatment. This report shows how individualized communication skills assessment allowed us to successfully manage a 9-year-old patient with CP, who suffered extrusive luxation of the permanent lower incisor. In the present case, the teeth were repositioned briefly after the trauma had occurred and then stabilized with a flexible splint according to international guidelines. The teeth remained vital and periodontal repair was observed during the 4-year follow-up.

PMID: [30604876](#)**11. GM1 Acupoint Injection Improves Mental Retardation in Children with Cerebral Palsy.**

Li E, Zhao P, Jian J, Wu H, Gao S, Zhai H.

J Mol Neurosci. 2019 Jan 2. doi: 10.1007/s12031-018-1239-3. [Epub ahead of print]

To study the clinical effectiveness and mechanism of GM1 acupoint injection therapy on mental retardation for children with cerebral palsy (CP). A total of 90 children with CP were divided into acupoint injection group (group A), subcutaneous injection group (group B), and control group (group C). Another 30 healthy children were set as a healthy control group (group D). The Mental Developmental Index (MDI), Psychomotor Developmental Index (PDI), and hemodynamic parameters in the cerebral arteries were measured before and after treatment. After three treatment courses, the MDI and PDI in groups A, B, and C were increased, and the increase in group A was most obvious ($P < 0.05$). Peak systolic velocity, mean velocity, and end-diastolic velocity were also elevated in group A, and after three treatment courses, resistance index decreased with a statistical significance ($P < 0.05$). However, there were no significant changes in groups B and C ($P > 0.05$). For all groups, neuron-specific enolase levels decreased and total superoxide dismutase increased after treatment. Acupoint injection therapy combined with conventional rehabilitation therapy demonstrated significant effects on cerebral hemodynamic conditions for children with CP.

PMID: [30604381](#)**12. Full Activation Profiles and Integrity of Corticospinal Pathways in Adults With Bilateral Spastic Cerebral Palsy.**

Condliffe EG, Jeffery DT, Emery DJ, Treit S, Beaulieu C, Gorassini MA.

Neurorehabil Neural Repair. 2018 Dec 29;1545968318818898. doi: 10.1177/1545968318818898. [Epub ahead of print]

BACKGROUND: Dysfunction of corticospinal pathways has been implicated in motor impairments in people with bilateral spastic cerebral palsy (CP). While structural damage to corticospinal pathways in people with CP is known, its impact on the activation of these pathways is not. **OBJECTIVE:** To provide the first, complete activation profile of corticospinal pathways in adults with CP using a full range of transcranial magnetic stimulation (TMS) intensities and voluntary contractions. **METHODS:** TMS targeted the soleus muscle of 16 adults with bilateral spastic CP and 15 neurologically intact (NI) control participants. Activation profiles were generated using motor-evoked potentials (MEPs) produced by varying both stimulation intensity and degree of voluntary muscle activity. Anatomical integrity of corticospinal pathways was also measured with diffusion tractography. **RESULTS:** Participants with CP had smaller MEPs produced by TMS at $1.2\times$ active motor threshold during submaximal (20%) muscle activity and smaller maximal MEPs produced under any combination of stimulation intensity and voluntary muscle activity. At a fixed stimulation intensity, increasing voluntary muscle activity facilitated MEP amplitudes to a lesser degree in the participants with CP. Consistent differences in diffusion tractography suggested structural abnormalities in the corticospinal pathways of participants with CP that correlated with maximal MEPs. **CONCLUSION:** People with bilateral spastic CP have impaired activation of low and high-threshold corticospinal pathways to soleus motoneurons by TMS and reduced facilitation by voluntary activity that may be associated with structural damage to these pathways. These impairments likely contribute to impaired voluntary movement.

PMID: [30595088](#)

13. Altered White Matter Connectivity Associated with Intergyrar Brain Disorganization in Hemiplegic Cerebral Palsy.

Papadelis C, Ahtam B, Feldman HA, AlHilani M, Tamilia E, Nimec D, Snyder B, Ellen Grant P, Im K.

Neuroscience. 2018 Dec 26. pii: S0306-4522(18)30844-3. doi: 10.1016/j.neuroscience.2018.12.028. [Epub ahead of print]

Despite extensive literature showing damages in the sensorimotor projection fibers of children with hemiplegic cerebral palsy (HCP), little is known about how these damages affect the global brain network. In this study, we assess the relationship between the structural integrity of sensorimotor projection fibers and the integrity of intergyral association white matter connections in children with HCP. Diffusion tensor imaging was performed in 10 children with HCP and 16 typically developing children. We estimated the regional and global white-matter connectivity using a region-of-interest (ROI)-based approach and a whole-brain gyrus-based parcellation method. Using the ROI-based approach, we tracked the spinothalamic (STh), thalamocortical (ThC), corticospinal (CST), and sensorimotor U- (SMU) fibers. Using the whole-brain parcellation method, we tracked the short-, middle-, and long-range association fibers. We observed for the more affected hemisphere of children with HCP: (i) an increase in axial diffusivity (AD), mean diffusivity (MD), and radial diffusivity (RD) for the STh and ThC fibers; (ii) a decrease in fractional anisotropy (FA) and an increase in AD, MD, and RD for the CST and SMU fibers; (iii) a decrease in FA for the short-range association fibers; (iv) a decrease in FA and an increase in AD, MD, and RD for the middle- and long-range association fibers; and (v) an association between the integrity of sensorimotor projection and intergyral association fibers. Our findings indicate that altered structural integrity of the sensorimotor projection fibers disorganizes the intergyral association white matter connections among local and distant regions in children with HCP.

PMID: [30593919](#)