Cerebral palsy research news

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CP Alliance Chair of Cerebral Palsy Research

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Interventions and Management

1. Bimanual hand use in children and adolescents with unilateral spastic cerebral palsy: an exploratory study

Simone A Bueno, Marisa C Mancini, Rachel H S Oliveira, Marina J Airoldi, Beatriz S Vieira, Andrew M Gordon, Marina B Brandão

Braz J Phys Ther. 2023 Nov 7;27(6):100561. doi: 10.1016/j.bjpt.2023.100561. Online ahead of print.

Background: Individuals with unilateral spastic cerebral palsy (USCP) often show difficulties using their hands during activities of daily living. Objective: To investigate the factors that interfere with hand use during bimanual activities in children and adolescents with USCP. Methods: We conducted a cross-sectional study with 102 children and adolescents with USCP, aged 6 to 18 years. We collected information with the caregivers about the classification of the child's manual ability, according to the Manual Ability Classification System (MACS); child's age; side of the involvement; Children's Hand-Use Experience Questionnaire- CHEQ2.0. Cluster analysis identified groups of children and adolescents who performed CHEQ activities with or without assistance. Multiple linear regression analyses identified the contribution of the factors: age, sex, MACS level, side of hemiparesis, and clusters of assistance, on the outcomes of efficacy, time, and feeling bothered. Results: MACS and clusters of assistance explained the variance in efficacy ($p<0.05$; $R2=0.31$) and time ($p<0.05$; $R2=0.37$). MACS explained 22% of the variance in feeling bothered. Children and adolescents with increased difficulty to perform activities that involve hand use (i.e., MACS III) and who receive assistance during most bimanual activities showed less efficacy of use, were slower in their performance, and presented greater feeling of being bothered. Conclusion: Assistance in bimanual activities and MACS level contributed to explain the efficacy of use, time, and feeling bothered in performing bimanual activities. Intervention strategies aimed at promoting the performance of bimanual activities in the daily routine of children with USCP should consider these outcomes.

PMID: 37979248

2. The upper limb in children with cerebral palsy. Evaluation and treatment

Frank Fitoussi, Pauline Lallemant Dudek

Review Orthop Traumatol Surg Res. 2023 Nov 20:103763. doi: 10.1016/j.otsr.2023.103763. Online ahead of print.

Management of the upper limb in children with cerebral palsy is often complex and must be carried out by a team experienced in this field. Several clinical parameters must be taken into consideration, such as higher functions, visual problems, overall upper limb function, motor control, sensitivity, presence of hemineglect or synkinesis, limb position at rest and during walking. And last but not least, a complete analysis of the upper limb is required. It is only after this exhaustive assessment-which often includes occupational therapy, physiotherapy and in some cases, video and electromyography evaluations-that a treatment indication can be discussed with the patient's family. Other than baseline treatment consisting of rehabilitation, occupational therapy and bracing, botulinum toxin injections could be an option, targeting specific muscle groups. Surgical treatments, which are often indicated in severe forms with contractures, are proposed after the patient's case is presented at a multidisciplinary meeting. These include selective neurotomy, muscle-tendon release, transfer or lengthening, and procedures on bone and joints (osteotomy, arthrodesis). Level of evidence: Expert opinion.

PMID: 37992866

3. Retrospective study of functional benefits and satisfaction in multisite upper-limb surgery in children with unilateral cerebral palsy

Audrey Combey, Rachel Bard-Pondarre, Lionel Erhard, Emmanuelle Chaleat-Valayer

Hand Surg Rehabil. 2023 Nov 22:S2468-1229(23)00580-7. doi: 10.1016/j.hansur.2023.11.008. Online ahead of print.

Objectives: To evaluate the functional impact of individualized multisite neuro-orthopedic upper-limb surgery in children with unilateral cerebral palsy, and to assess patient satisfaction. Patients and methods: This retrospective study evaluated the impact of surgery on unilateral functional capacity on the Melbourne Assessment (MA2) and Box and Blocks test, on bimanual performance on the Assisting Hand Assessment, and on achievement of individualized goals. Satisfaction was assessed on a Likert scale between 6 and 14 months after surgery. Results: Twenty-three children were included (mean age, 13.2 ± 3 years). They underwent neuro-orthopedic surgery as part of their care pathway, with botulinum toxin, splints and functional training. After surgery, there was a significant 11.7-point improvement in the MA2 dexterity domain ($p = 0.003$) and 10.6 points in the MA2 range of motion domain ($p = 0.005$). Satisfaction was high in 81% of patients. Conclusion: Neuro-orthopedic upper-limb surgery included in a global care pathway in children with unilateral cerebral palsy improved unilateral upper-limb function and patient satisfaction. The present cohort should be expanded to further explore the impact of surgery on bimanual performance, focusing on more homogeneous functional levels and surgical procedures.

PMID: 38000449

4. 15 Years of Spinal Fusion Outcomes in Children with Cerebral Palsy: Are We Getting Better?

Daniel Badin, Suken A Shah, Unni G Narayanan, Patrick J Cahill, Majd Marrache, Amer F Samdani, Burt Yaszay, Joann B Hunsberger, Michelle C Marks 8, Paul D Sponseller; HARMS Study Group

Spine (Phila Pa 1976). 2023 Nov 22. doi: 10.1097/BRS.0000000000004792. Online ahead of print.

Study design: Retrospective Multicenter Study. Objective: We reviewed 15-year trends in operative factors, radiographic and quality-of-life outcomes, and complication rates in children with cerebral palsy (CP) related scoliosis who underwent spinal fusion. Summary of background data: Over the past 2 decades, significant efforts have been made to decrease complications and improve outcomes of this population. Methods: We retrospectively reviewed a multicenter registry of pediatric CP patients who underwent spinal fusion from 2008 to 2020. We evaluated baseline and operative, hospitalization, and complication data as well as radiographic and quality-of-life outcomes at a minimum 2-year follow-up. Results: Mean estimated blood loss and transfusion volume declined from 2.7±2.0 L in 2008 to 0.71±0.34 L in 2020 and 1.0±0.5 L in 2008 to 0.5±0.2 L in 2020, respectively, with a concomitant increase in antifibrinolytic use from 58% to 97% (all, $P<0.01$). Unit rod and pelvic fusion use declined from 33% in 2008 to 0% in 2020 and 96% in 2008 to 79% in 2020, respectively (both, $P<0.05$). Mean postoperative intubation time declined from 2.5±2.6 days to 0.42±0.63 days ($P<0.01$). No changes were observed in pre- and post-operative coronal angle and pelvic obliquity, operative time, frequency of anterior/anterior-posterior approach, and durations of hospital and intensive care unit stays. Improvements in the Caregiver Priorities and Child Health Index of Life with Disabilities postoperatively did not change significantly over the study period. Complication rates, including reoperation, superficial and deep surgical site infection, and gastrointestinal and medical complications remained stable over the study period. Conclusions: Over the past 15 years of CP-scoliosis surgery, surgical blood loss, transfusion volumes, duration of postoperative intubation, and pelvic fusion rates have decreased. However, the degree of radiographic correction, the rates of surgical and medical complications (including infection), and health-related quality-of-life measures have broadly remained constant. Level of evidence: 3.

PMID: 37991210

5. Single-Event Multi-Level Surgery in Cerebral Palsy: A Bibliometric Analysis

Norine Ma, Daniel Gould, Carlo Camathias, Kerr Graham, Erich Rutz

Review Medicina (Kaunas). 2023 Oct 30;59(11):1922. doi: 10.3390/medicina59111922.

Background and Objectives: Single-Event Multi-Level Surgery (SEMLS) is a complex surgical programme in which soft tissue contractures and bony torsional deformities at the ankle, knee and hip, in both lower limbs are surgically corrected during a single operative session, requiring one hospital admission and one period of rehabilitation. The aim of SEMLS is to improve gait and function in ambulant children with cerebral palsy. Utilisation of the SEMLS concept can reduce the number of surgical events, hospital inpatient stays and reduce rehabilitation requirements to a single intensive episode. Three-dimensional gait analysis is a pre-requisite to plan intervention at multiple anatomic levels to correct fixed deformities and to improve gait and function. Materials and Methods: This study was a bibliometric analysis of SEMLS in cerebral palsy using the Clarivate Web of Science Core Collection database from 1900 to 29 May 2023. Results: A total of 84 studies met the inclusion criteria. The

most highly cited article was "Correction of severe crouch gait in patients with spastic diplegia with use of multilevel orthopaedic surgery" by Rodda et al. (2006) with 141 citations. The most productive institutions by number of articles were the Royal Children's Hospital Melbourne (Australia), Murdoch Children's Research Institute (Australia) and University of Melbourne (Australia). The most productive author by number of citations was HK Graham (Australia). Conclusions: The literature base for SEMLS consists largely of retrospective cohort studies. The aforementioned three institutes in Melbourne, Australia, which frequently collaborate together, have contributed the greatest number of studies in this field.

PMID: 38003972

6. Reduced reciprocal inhibition during clinical tests of spasticity is associated with impaired reactive standing balance control in children with cerebral palsy

Jente Willaert, Lena H Ting, Anja Van Campenhout, Kaat Desloovere, Friedl De Groote

medRxiv. 2023 Nov 8:2023.11.07.23298160. doi: 10.1101/2023.11.07.23298160. Preprint

Background: Joint hyper-resistance is a common symptom in cerebral palsy (CP). It is assessed by rotating the joint of a relaxed patient. Joint rotations also occur when perturbing functional movements. Therefore, joint hyper-resistance might contribute to reactive balance impairments in CP. Aim: To investigate relationships between altered muscle responses to isolated joint rotations and perturbations of standing balance in children with CP. Methods & procedures: 20 children with CP participated in the study. During an instrumented spasticity assessment, the ankle was rotated as fast as possible from maximal plantarflexion towards maximal dorsiflexion. Standing balance was perturbed by backward support-surface translations and toe -up support-surface rotations. Gastrocnemius, soleus, and tibialis anterior electromyography was measured. We quantified reduced reciprocal inhibition by plantarflexor-dorsiflexor co-activation and the neural response to stretch by average muscle activity. We evaluated the relation between muscle responses to ankle rotation and balance perturbations using linear mixed models. Outcomes & results: Co-activation during isolated joint rotations and perturbations of standing balance was correlated across all levels. The neural response to stretch during isolated joint rotations and balance perturbations was not correlated. Conclusions & implications: Reduced reciprocal inhibition during isolated joint rotations might be a predictor of altered reactive balance control strategies. Highlights: Impaired reciprocal inhibition might underlie altered balance control in CP.Co-activation during isolated joint rotations and balance responses is correlated. Hyperreflexia is not correlated with increased response to perturbations of standing. Reduced reciprocal inhibition has functional implications. It might be valuable to clinically assess reduced reciprocal inhibition. What this paper adds: It has been hard to relate alterations in muscle coordination during functional movements to alterations in the muscle's response to isolated joint rotations as applied during (clinical) assessments of hyper-reflexia. Here, we performed a more comprehensive assessment of the altered muscle response to isolated joint rotations in children with cerebral palsy (CP) by not only considering muscle activity in response to stretch but also agonist-antagonist co-activation. Muscle co-activation in response to isolated joint rotations in relaxed patients has been attributed to reduced reciprocal inhibition in the spinal cord. We found that muscle co-activation during isolated joint rotations was correlated to muscle co-activation during perturbed standing, an important functional movement. Therefore, increased muscle co-activation during standing balance control might - at least partially - result from reduced reciprocal inhibition in the spinal cord. In contrast, we found very few relations between the mean muscle activity during isolated joint rotations and perturbed standing. This might be due to the sensitivity of the response to stretch to stretch velocity, posture, and baseline muscle activity, all of which largely differed between the two conditions. Our results indicate that clinical assessment of reduced reciprocal inhibition during isolated joint rotations might provide information about balance impairments.

PMID: 37986791

7. Supported standing and stepping device use in young children with cerebral palsy, gross motor function classification system III, IV and V: a descriptive study

Roslyn W Livingstone, Ginny S Paleg, Debra A Field

Assist Technol. 2023 Nov 21. doi: 10.1080/10400435.2023.2283461. Online ahead of print.

This study described and compared use of supported-standing and stepping devices by young children with cerebral palsy, Gross-Motor Function Classification System (GMFCS) levels III-V following power mobility introduction. Data was collected at two time-points, 5-6 months apart, for 42 participants, aged 18-80 months, using the Home Use of Technology for CHildren (HUTCH). Supported-standing and stepping device choice, and time in each device remained stable over 6 months. Associations between device use and three functional classifications were examined. Children with more impaired motor, postural and manual abilities were more likely to use a supine stander rather than a prone/upright stander or no stander. Children at GMFCS V tended to use hands-free stepping devices, while support-arms stepping devices were more common for children at GMFCS IV. Only children at GMFCS III used convertible stepping devices. Using power mobility, standers and supported-stepping devices was feasible and 19/34 classified at GMFCS IV/V used all three devices over 6 months. A key finding was that introduction of power mobility did not reduce use of supported-stepping devices at any GMFCS level. Use of multiple upright positioning and mobility devices may assist children with limited mobility to be actively engaged and participate in daily life.

PMID: 37988126

8. Time course of surface electromyography during walking of children with spastic cerebral palsy treated with botulinum toxin type A and its rehabilitation implications

Matteo Cioni, Antonino Casabona, Rosario Ferlito, Mariangela Pisasale, Domenico Marco Romeo, Giulia Messina, Maria Stella Valle

Clin Biomech (Bristol, Avon). 2023 Nov 15:111:106147. doi: 10.1016/j.clinbiomech.2023.106147. Online ahead of print.

Background: The timing of the effects of botulinum toxin A on spastic muscles is not yet fully clarified. The goal of this study was to follow the temporal changes of surface electromyographic activity of lower limb muscles during walking, after a therapeutic dose of botulinum toxin A injected into the calf muscles of children with spastic cerebral palsy. Methods: A group of children with spastic equinus foot was administered botulinum toxin A into the gastrocnemius medialis and lateralis muscles. Surface electromyographic activity of the tibialis anterior, gastrocnemius medialis, rectus femoris and medial hamstrings, was recorded before botulinum toxin A injections and after 4, 8, and 16 weeks. Children walked on ground and on a treadmill at an incline of 0% and 12%. The area of electromyographic activity and the index of muscle co-contraction were calculated for specific segments of gait cycle. Findings: Botulinum toxin A did not modify the speed of gait on ground. ANOVA showed significant differences in electromyography during the stance phase segments with a maximum decrease between 4 and 8 weeks' post botulinum toxin A and a full recovery at 16 weeks. A significant co-contraction of rectus femoris/ gastrocnemius medialis, between 0 and 20% and 35-50% of the gait cycle, was observed from the 4th to the 8th week post-botulinum toxin A for both treadmill settings. Interpretation: The temporal identification of deterioration/recovery of electromyographic activity as well as of muscle co-contractions, could be key elements in a rehabilitation program planning combined with botulinum toxin A.

PMID: 37988778

9. Functional popliteal angle tests improve identification of short hamstring muscle-tendon length in patients with a central neurological lesion

Mahdieh Hajibozorgi, Ilse Leijen, Juha M Hijmans, Christian Greve

Sci Rep. 2023 Nov 22;13(1):20510. doi: 10.1038/s41598-023-47667-8.

This study introduces a functional exercise protocol to improve the identification for short hamstring muscle-tendon length (HMTL), a common contributor to crouch gait in patients with central neurological lesions (CNL). The functional exercise protocol incorporates a knee extension movement with hip in a flexed position, while standing on one leg (functional popliteal angle test) and walking with large steps to the current standard protocol (walking at comfortable speed and as fast as possible). The main aim was to establish whether the new protocol allows better determination of maximum HMTLs and diagnostics of short HMTL in patients with a CNL. Lower limb 3D marker position data from 39 patient limbs and 10 healthy limbs performing the exercises were processed in OpenSim to extract HMTLs. The new protocol provoked significantly larger HMTLs compared to the current standard protocol. The total number of limbs classified as having too short HMTLs reduced from 16 to 4 out of a total of 30 limbs walking in crouch. The new protocol improves determination of maximum HMTL, thereby improving short HMTL diagnostics and identification of patients in need of lengthening treatment. Inter-individual variability observed among patients, indicating the need to include all exercises for comprehensive diagnosis.

PMID: 37993595

10. Interpretable classification for multivariate gait analysis of cerebral palsy

Changwon Yoon, Yongho Jeon, Hosik Choi, Soon-Sun Kwon, Jeongyoun Ahn

Biomed Eng Online. 2023 Nov 22;22(1):109. doi: 10.1186/s12938-023-01168-x.

Background: The Gross Motor Function Classification System (GMFCS) is a widely used tool for assessing the mobility of people with Cerebral Palsy (CP). It classifies patients into different levels based on their gross motor function and its level is typically determined through visual evaluation by a trained expert. Although gait analysis is commonly used in CP research, the functional aspects of gait patterns has yet to be fully exploited. By utilizing the gait patterns to predict GMFCS, we can gain a more comprehensive understanding of how CP affects mobility and develop more effective interventions for CP patients. Result: In this study, we propose a multivariate functional classification method to examine the relationship between kinematic gait measures and GMFCS levels in both normal individuals and CP patients with varying GMFCS levels. A sparse linear functional discrimination framework is utilized to achieve an interpretable prediction model. The method is generalized to handle multivariate functional data and multi-class classification. Our method offers competitive or improved prediction accuracy compared to state-of-the-art functional classification approaches and provides interpretable discriminant functions

that can characterize the kinesiological progression of gait corresponding to higher GMFCS levels. Conclusion: We generalize the sparse functional linear discrimination framework to achieve interpretable classification of GMFCS levels using kinematic gait measures. The findings of this research will aid clinicians in diagnosing CP and assigning appropriate GMFCS levels in a more consistent, systematic, and scientifically supported manner.

PMID: 37993868

11. Whole Genome Expression Profiling of Semitendinosus Tendons from Children with Diplegic and Tetraplegic Cerebral Palsy

Simona Nemska, Simone Serio, Veronica Larcher, Giulia Beltrame, Nicola Marcello Portinaro, Marie-Louise Bang

Biomedicines. 2023 Oct 28;11(11):2918. doi: 10.3390/biomedicines11112918.

Cerebral palsy (CP) is the most common movement disorder in children, with a prevalence ranging from 1.5 to 4 per 1000 live births. CP is caused by a non-progressive lesion of the developing brain, leading to progressive alterations of the musculoskeletal system, including spasticity, often leading to the development of fixed contractures, necessitating tendon lengthening surgery. Total RNA-sequencing analysis was performed on semitendinosus tendons from diplegic and tetraplegic CP patients subjected to tendon lengthening surgery compared to control patients undergoing anterior cruciate ligament reconstructive surgery. Tetraplegic CP patients showed increased expression of genes implicated in collagen synthesis and extracellular matrix (ECM) turnover, while only minor changes were observed in diplegic CP patients. In addition, tendons from tetraplegic CP patients showed an enrichment for upregulated genes involved in vesicle-mediated transport and downregulated genes involved in cytokine and apoptotic signaling. Overall, our results indicate increased ECM turnover with increased net synthesis of collagen in tetraplegic CP patients without activation of inflammatory and apoptotic pathways, similar to observations in athletes where ECM remodeling results in increased tendon stiffness and tensile strength. Nevertheless, the resulting increased tendon stiffness is an important issue in clinical practice, where surgery is often required to restore joint mobility.

PMID: 38001919

12. Safety and Feasibility of Functional Repetitive Neuromuscular Magnetic Stimulation of the Gluteal Muscles in Children and Adolescents with Bilateral Spastic Cerebral Palsy

Leonie Grosse, Julian F Schnabel, Corinna Börner-Schröder, Malina A Späh, Anne C Meuche, Nico Sollmann, Ute Breuer, Birgit Warken, Matthias Hösl, Florian Heinen, Steffen Berweck, Sebastian A Schröder, Michaela V Bonfert

Children (Basel). 2023 Oct 31;10(11):1768. doi: 10.3390/children10111768.

Background: For children and adolescents affected by bilateral spastic cerebral palsy (BSCP), non-invasive neurostimulation with repetitive neuromuscular magnetic stimulation (rNMS) combined with physical exercises, conceptualized as functional rNMS (frNMS), represents a novel treatment approach. Methods: In this open-label study, six children and two adolescents (10.4 ± 2.5 years) with BSCP received a frNMS intervention targeting the gluteal muscles (12 sessions within 3 weeks). Results: In 77.1% of the sessions, no side effects were reported. In 16.7%, 6.3% and 5.2% of the sessions, a tingling sensation, feelings of pressure/warmth/cold or very shortly lasting pain appeared, respectively. frNMS was highly accepted by families (100% adherence) and highly feasible (97.9% of treatment per training protocol). A total of 100% of participants would repeat frNMS, and 87.5% would recommend it. The Canadian Occupational Performance Measure demonstrated clinically important benefits for performance in 28% and satisfaction in 42% of mobility-related tasks evaluated by caregivers for at least one follow-up time point (6 days and 6 weeks post intervention). Two patients accomplished goal attainment for one mobility-related goal each. One patient experienced improvement for both predefined goals, and another participant experienced improvement in one and outreach of the other goal as assessed with the goal attainment scale. Conclusions: frNMS is a safe and well-accepted neuromodulatory approach that could improve the quality of life, especially in regard to activity and participation, of children and adolescents with BSCP. Larger-scaled studies are needed to further explore the effects of frNMS in this setting.

PMID: 38002859

13. [Translated article] Improving health-related quality of life in middle-age children with cerebral palsy following selective percutaneous myofascial lengthening and functional physiotherapy [Article in English, Spanish]

V C Skoutelis, A D Kanellopoulos, S Vrettos, Z Dimitriadis, A Dinopoulos, P J Papagelopoulos, V A Kontogeorgakos

Rev Esp Cir Ortop Traumatol. 2023 Nov 21:S1888-4415(23)00250-3. doi: 10.1016/j.recot.2023.11.018. Online ahead of print.

Introduction and objectives: Children with cerebral palsy (CP) experience decreased health-related quality of life (HRQOL).

This study aimed to assess the HRQOL of children with CP before versus after a combined program of minimally invasive selective percutaneous myofascial lengthening (SPML) and functional physiotherapy. Material and methods: A single-group pre-posttest design was used. Twenty-six middle childhood children with spastic CP, aged 5-7 years, with Gross Motor Function Classification System levels II-IV underwent SPML surgery and 9 months of postoperative functional strength training therapy. The proxy version of the DISABKIDS-Smiley questionnaire was completed by one parent of each child. Dependent t-tests were used to compare mean pre- and post-measurement scores. Results: After the 9-month intervention, the children with CP had significantly higher quality of life scores (mean difference, 11.06 ± 9.05; 95% confidence interval [CI], 7.40-14.71; $p < 0.001$). Conclusions: This study demonstrated that children with CP had better HRQOL after a combined program of minimally invasive SPML surgery and functional physiotherapy (ACTRN12618001535268).

PMID: 37995817

14. Pain in children with cerebral palsy as reported by parents

Maysoun Nimer Saleh, Nihad Ali Almasri, Basil Al Bakri

Child Care Health Dev. 2023 Nov 21. doi: 10.1111/cch.13204. Online ahead of print.

Background: Pain in children with cerebral palsy (CP) is a problem that has not received adequate attention in developing countries. The aim of this study was to explore the presence of pain and common sites of pain in children with CP based on age, gender and ambulatory status as determined by the Gross Motor Function Classification System (GMFCS) level. Methods: This was a cross-sectional study based on data from a CP registry (CPUP-Jordan). Participants were 310 children with CP (mean age: 3.3 ± 2.9 years, range: 5 months to 15.9 years), 77.1% were below 5 years of age, 56.8% were boys and 49% were classified as Levels IV and V of the GMFCS. Parents were asked to indicate whether their child is currently experiencing pain (yes/no); if yes, they were asked to report the sites of pain. Results: Seventy-nine (25.5%) children experienced pain (34.1% had pain in the stomach, 15.2% at the hips and knees and 12.7% in their feet). The presence of pain did not significantly differ by age or gender. More children in GMFCS Levels V (34.7%) and IV (31.6%) experienced pain. Compared with Level V on the GMFCS (non-ambulant children), children in Level I and children in Level III experienced less pain (odds ratio [OR] = 0.25, 95% confidence interval [CI] = 0.087-0.727, $p = 0.011$; OR = 0.42, 95% CI = 0.18-0.98, $p = 0.045$, respectively). Pain sites differed with age and GMFCS. Conclusions: Pain was reported to be less than previous studies. Non-ambulant children experienced more pain. Pain monitoring and management should be a regular practice in rehabilitation for this population, with special attention for non-ambulant children.

PMID: 37988246

15. Boosting brain-computer interfaces with functional electrical stimulation: potential applications in people with locked-in syndrome

Evan Canny, Mariska J Vansteensel, Sandra M A van der Salm, Gernot R Müller-Putz, Julia Berezutskaya

Review J Neuroeng Rehabil. 2023 Nov 18;20(1):157. doi: 10.1186/s12984-023-01272-y.

Individuals with a locked-in state live with severe whole-body paralysis that limits their ability to communicate with family and loved ones. Recent advances in brain-computer interface (BCI) technology have presented a potential alternative for these people to communicate by detecting neural activity associated with attempted hand or speech movements and translating the decoded intended movements to a control signal for a computer. A technique that could potentially enrich the communication capacity of BCIs is functional electrical stimulation (FES) of paralyzed limbs and face to restore body and facial movements of paralyzed individuals, allowing to add body language and facial expression to communication BCI utterances. Here, we review the current state of the art of existing BCI and FES work in people with paralysis of body and face and propose that a combined BCI-FES approach, which has already proved successful in several applications in stroke and spinal cord injury, can provide a novel promising mode of communication for locked-in individuals.

PMID: 37980536

16. Disruption of Sensorimotor Cortical Oscillations by Visual Interference Predicts the Altered Motor Performance of Persons with Cerebral Palsy

Morgan T Busboom, Rashelle M Hoffman, Rachel K Spooner, Brittany K Taylor, Sarah E Baker, Michael P Trevarrow, Tony W Wilson, Max J Kurz

Neuroscience. 2023 Nov 21:S0306-4522(23)00512-2. doi: 10.1016/j.neuroscience.2023.11.017. Online ahead of print.

Emerging evidence indicates that aberrations in sensorimotor cortical oscillations likely play a key role in uncharacteristic motor actions seen in cerebral palsy. This interpretation is largely centered on the assumption that the aberrant cortical

oscillations primarily reflect the motor aspects, with less consideration of possible higher-order cognitive connections. To directly probe this view, we examined the impact of cognitive interference on the sensorimotor cortical oscillations seen in persons with cerebral palsy using magnetoencephalography. Persons with cerebral palsy (N = 26, 9-47 years old) and controls (N = 46, 11-49 years) underwent magnetoencephalographic imaging while completing an arrow-based version of the Eriksen flanker task. Structural equation modeling was used to evaluate the relationship between the extent of interference generated by the flanker task and the strength of the sensorimotor cortical oscillations and motor performance. Our results indicated that the impact of cognitive interference on beta and gamma oscillations moderated the interference effect on reaction times in persons with cerebral palsy, above and beyond that seen in controls. Overall, these findings suggest that alterations in sensorimotor oscillatory activity in those with cerebral palsy at least partly reflects top-down control influences on the motor system. Thus, suppression of distracting stimuli should be a consideration when evaluating altered motor actions in cerebral palsy.

PMID: 37996052

17. Application of 3D scanner to measure physical size and improvement of hip brace manufacturing technology in severe cerebral palsy patients

Jung-Min Kim, Jiwoon Lim, Sun-Young Choi, Sung-Han Rhim, Jaewon Beom, Ju Seok Ryu

Sci Rep. 2023 Nov 24;13(1):20691. doi: 10.1038/s41598-023-47665-w.

This prospective pilot study aimed to develop a personalized hip brace for treating hip subluxation in children with cerebral palsy. Nineteen children, aged 1-15, with severe cerebral palsy participated in the study. Customized hip braces were created based on 3D scanner measurements and worn for 7 days. The primary outcome, Hip Migration Index (MI), and secondary outcomes, including range of motion (ROM) in the hip and knee joints, pain intensity, satisfaction, discomfort scores, CPCHILD, and wearability test, were assessed. The MI and ROM were assessed at screening and at Visit 1 (when the new hip brace was first worn), while other indicators were evaluated at screening, Visit 1, and Visit 2 (7 days after wearing the new hip brace). The study demonstrated significant improvements in the MI for the right hip, left hip, and both sides. However, there were no statistically significant differences in hip and knee joint ROM. Other indicators showed significant changes between screening, Visit 1, and Visit 2. The study suggests that customized hip braces effectively achieved immediate correction, positively impacting the quality of life and satisfaction in children with cerebral palsy. Furthermore, the hip braces have the potential to enhance compliance and prevent hip subluxation. Clinical Trial Registration number: NCT05388422.

PMID: 38001232

18. Creating an AI-Enhanced Morse Code Translation System Based on Images for People with Severe Disabilities

Chung-Min Wu, Yeou-Jiunn Chen, Shih-Chung Chen, Sheng-Feng Zheng

Bioengineering (Basel). 2023 Nov 3;10(11):1281. doi: 10.3390/bioengineering10111281.

(1) Background: Patients with severe physical impairments (spinal cord injury, cerebral palsy, amyotrophic lateral sclerosis) often have limited mobility due to physical limitations, and may even be bedridden all day long, losing the ability to take care of themselves. In more severe cases, the ability to speak may even be lost, making even basic communication very difficult. (2) Methods: This research will design a set of image-assistive communication equipment based on artificial intelligence to solve communication problems of daily needs. Using artificial intelligence for facial positioning, and facial-motion-recognition-generated Morse code, and then translating it into readable characters or commands, it allows users to control computer software by themselves and communicate through wireless networks or a Bluetooth protocol to control environment peripherals. (3) Results: In this study, 23 human-typed data sets were subjected to recognition using fuzzy algorithms. The average recognition rates for expert-generated data and data input by individuals with disabilities were 99.83% and 98.6%, respectively. (4) Conclusions: Through this system, users can express their thoughts and needs through their facial movements, thereby improving their quality of life and having an independent living space. Moreover, the system can be used without touching external switches, greatly improving convenience and safety.

PMID: 38002405

19. Validation of the French version of the Caregivers' Priorities and Child Health Index of Life with Disabilities questionnaire

Audrey Angelliaume, Luke Harper, Aurore Bouty, Cécile Bouteiller, Brigitte Deleplanque, Magaly Ravel, Malo Le Hanneur, Unni G Narayanan, Cyril Ferdynus, Clémence Pfirrmann

Orthop Traumatol Surg Res. 2023 Nov 16:103753. doi: 10.1016/j.otsr.2023.103753. Online ahead of print.

Introduction: The Caregivers' Priorities and Child Health Index of Life with Disabilities (CPCHILD) is a questionnaire that

measures the health-related quality of life (HRQL) of children with cerebral palsy (CP). Though measuring HRQL is challenging in these children, it is a valuable help for medical decision-making. There is no questionnaire to assess HRQL in French-speaking children with severe CP. Objective: To translate and adapt transculturally the CPCHILD questionnaire into French (CPCHILD-FV). Material and methods: The CPCHILD was translated from English into French by forward and backward translation by independents translators. The questionnaire was then tested on 32 caregivers of patients with CP classified as GMFCS IV or V, remarks of caregivers were analyzed by an expert committee and, if necessary, modifications were performed. Internal consistency of the CPCHILD-FV was assessed using a sample of 32 parents or caregivers and test-retest reliability was assessed on a random sample of 10 patients. Results: The translation and transcultural process resulted in a French version of the CPCHILD. Some items of the CPCHILD required careful discussion to ensure that items had the same meaning as in the original. Internal consistencies were over 0.70 for each domain except for health, and 0.97 for the total scores. The ICC for the test-retest reliability of the CHILD-FV total score was 0.98 (95% CI: 0.93-0.99) and ranged from 0.59 to 0.99 for the domains. Conclusion: The translation and cross-cultural adaptation of the CPCHILD questionnaire provides a French version than can measure the HRQL of children with severe CP. Level of evidence: IV; prospective study without control group.

PMID: 37979675

20. Modified sports interventions for children with cerebral palsy: Enhancing perspectives in low- and middle-income countries

Cassy Boey

Dev Med Child Neurol. 2023 Nov 20. doi: 10.1111/dmcn.15806. Online ahead of print.

No abstract available

PMID: 37986227

21. The role of cerebral palsy registries in improving patient care and collaboration: A global perspective

Egil Bakkeheim

Dev Med Child Neurol. 2023 Nov 20. doi: 10.1111/dmcn.15814. Online ahead of print.

No abstract available

PMID: 37986232

22. Adults with cerebral palsy and chronic pain experience: A cross-sectional analysis of patient-reported outcomes from a novel North American registry

Cristina A Sarmiento, Mary E Gannotti, Paul H Gross, Deborah E Thorpe, Edward A Hurvitz, Garey H Noritz, Susan D Horn, Michael E Msall, Henry G Chambers, Linda E Krach

Disabil Health J. 2023 Nov 13:101546. doi: 10.1016/j.dhjo.2023.101546. Online ahead of print.

Background: Chronic pain is common among adults with cerebral palsy (CP) and an area of priority for research and treatment. Objective: Describe the pain experience and its functional and quality of life impact among adults with CP with chronic pain in the community. Methods: Cross-sectional analysis of adult patient-reported outcomes collected by the Cerebral Palsy Research Network Community Registry. Results: Among all participants in the Community Registry, n = 205 reported having chronic pain, and 73 % of those (n = 149) completed the Chronic Pain Survey Bundle (75 % female; mean age 43 years (SD 14 years); 94 % White; 91 % non-Hispanic). Back and weight-bearing joints of lower extremities were most frequently reported as painful. There were no differences in average pain severity scores between varying GMFCS levels ($H = 6.25$, $p = 0.18$) and age groups ($H = 3.20$, $p = 0.36$). Several nonpharmacologic interventions were most frequently reported as beneficial. Participants with moderate to severe average pain scores (5-10) had higher levels of pain interference ($p < 0.01$) and depression ($p < 0.01$), and lower levels of satisfaction with social roles ($p < 0.01$) and lower extremity function ($p < 0.01$). Pain interference was significantly positively correlated with depression, and negatively correlated with upper and lower extremity function and satisfaction with social roles. Conclusions: Chronic pain is experienced by adults with CP of varying ages and functional levels and is associated with several adverse quality of life and functional outcomes. Improved understanding of chronic pain in this population will facilitate the development and study of treatment interventions optimizing health, function, participation, and quality of life.

PMID: 37993325

23. Accurate Monitoring of 24-h Real-World Movement Behavior in People with Cerebral Palsy Is Possible Using Multiple Wearable Sensors and Deep Learning

Ivana Bardino Novosel, Anina Ritterband-Rosenbaum, Georgios Zampoukis, Jens Bo Nielsen, Jakob Lorentzen

Sensors (Basel). 2023 Nov 8;23(22):9045. doi: 10.3390/s23229045.

Monitoring and quantifying movement behavior is crucial for improving the health of individuals with cerebral palsy (CP). We have modeled and trained an image-based Convolutional Neural Network (CNN) to recognize specific movement classifiers relevant to individuals with CP. This study evaluates CNN's performance and determines the feasibility of 24-h recordings. Seven sensors provided accelerometer and gyroscope data from 14 typically developed adults during videotaped physical activity. The performance of the CNN was assessed against test data and human video annotation. For feasibility testing, one typically developed adult and one adult with CP wore sensors for 24 h. The CNN demonstrated exceptional performance against test data, with a mean accuracy of 99.7%. Its general true positives (TP) and true negatives (TN) were 1.00. Against human annotators, performance was high, with mean accuracy at 83.4%, TP 0.84, and TN 0.83. Twenty-four-hour recordings were successful without data loss or adverse events. Participants wore sensors for the full wear time, and the data output were credible. We conclude that monitoring real-world movement behavior in individuals with CP is possible with multiple wearable sensors and CNN. This is of great value for identifying functional decline and informing new interventions, leading to improved outcomes.

PMID: 38005433

24. PPAR Gamma Receptor: A Novel Target to Improve Morbidity in Preterm Babies

Suresh Victor, Ben Forbes, Anne Greenough, A David Edwards

Review Pharmaceuticals (Basel). 2023 Oct 27;16(11):1530. doi: 10.3390/ph16111530.

Worldwide, three-quarters of a million babies are born extremely preterm (<28 weeks gestation) with devastating outcomes: 20% die in the newborn period, a further 35% develop bronchopulmonary dysplasia (BPD), and 10% suffer from cerebral palsy. Pioglitazone, a Peroxisome Proliferator Activated Receptor Gamma (PPARγ) agonist, may reduce the incidence of BPD and improve neurodevelopment in extreme preterm babies. Pioglitazone exerts an anti-inflammatory action mediated through Nuclear Factor-kappa B repression. PPARγ signalling is underactive in preterm babies as adiponectin remains low during the neonatal period. In newborn animal models, pioglitazone has been shown to be protective against BPD, necrotising enterocolitis, and lipopolysaccharide-induced brain injury. Single Nucleotide Polymorphisms of PPARγ are associated with inhibited preterm brain development and impaired neurodevelopment. Pioglitazone was well tolerated by the foetus in reproductive toxicology experiments. Bladder cancer, bone fractures, and macular oedema, seen rarely in adults, may be avoided with a short treatment course. The other effects of pioglitazone, including improved glycaemic control and lipid metabolism, may provide added benefit in the context of prematurity. Currently, there is no formulation of pioglitazone suitable for administration to preterm babies. A liquid formulation of pioglitazone needs to be developed before clinical trials. The potential benefits are likely to outweigh any anticipated safety concerns.

PMID: 38004396

25. Investigation of the Relationship between Sensory-Processing Skills and Motor Functions in Children with Cerebral Palsy

Serhat Erkek, Çiğdem Çekmece

Children (Basel). 2023 Oct 24;10(11):1723. doi: 10.3390/children10111723.

The main purpose of this study is to examine the relationship between sensory-processing skills and gross motor functions, bimanual motor functions, and balance in children with cerebral palsy (CP). A total of 47 patients between the ages of 3 and 10, diagnosed with CP, who received or applied for treatment in our physical therapy and rehabilitation unit were included in the study. Sensory profiling (SP), assisting hand assessment (AHA), the Gross Motor Function Measure-66 (GMFM-66), and the Pediatric Berg Balance Scale (PBBS) were used in the evaluation of the children with CP who participated in the study. The Gross Motor Function Classification System (GMFCS) was used to classify the children based on functional abilities and limitations, and the Manual Ability Classification System (MACS) was used to classify the children based on manual dexterity. The SP parameters were compared with AHA, GMFM-66, and PBBS results, and with GMFCS and MACS levels. Statistically significant relationships were found between AHA and SP, PBBS, and SP and between GMFM-66 and SP ($p < 0.05$). Our study shows that there are some disorders in sensory processing in children with CP. We think that sensory evaluations should be included in the CP rehabilitation program.

PMID: 38002814

26. Application of Virtual Reality-Assisted Exergaming on the Rehabilitation of Children with Cerebral Palsy: A Systematic Review and Meta-Analysis

Muhammad Abubaker Tobaiqi, Emad Ali Albadawi, Hammad Ali Fadlalmola, Muayad Saud Albadrani

Review J Clin Med. 2023 Nov 14;12(22):7091. doi: 10.3390/jcm12227091.

Background: Rehabilitation programs for children with cerebral palsy (CP) aim to improve their motor and cognitive skills through repeated and progressively challenging exercises. However, these exercises can be tedious and demotivating, which can affect the effectiveness and feasibility of the programs. To overcome this problem, virtual reality VR-assisted exergaming has emerged as a novel modality of physiotherapy that combines fun and motivation with physical activity. VR exergaming allows children with CP to perform complex movements in a secure and immersive environment, where they can interact with virtual objects and scenarios. This enhances their active engagement and learning, as well as their self-confidence and enjoyment. We aim to provide a comprehensive overview of the current state of research on VR exergaming for CP rehabilitation. The specific objectives are: To identify and describe the existing studies that have investigated the effects of VR exergaming on motor function and participation outcomes in children with CP. In addition, we aim to identify and discuss the main gaps, challenges, and limitations in the current research on VR exergaming for CP rehabilitation. Finally, we aim to provide recommendations and suggestions for future research and practice in this field. Methods: In June 2023, we conducted a systematic search on Scopus, Web of Science, PubMed, Cochrane, and Embase for randomized trials and cohort studies that applied VR-assisted exergaming to rehabilitating patients with CP. The inclusion criteria encompassed the following: (1) Randomized controlled trials (RCTs) and cohort studies involving the rehabilitation of children with CP; (2) the application of VR-based exergaming on the rehabilitation; (3) in comparison with conventional rehabilitation/usual care. The quality of the selected RCTs was evaluated using Cochrane's tool for risk of bias assessment bias includes. Whereas the quality of cohort studies was assessed using the National Institutes of Health (NIH) tool. Results: The systematic search of databases retrieved a total of 2576 studies. After removing 863 duplicates, 1713 studies underwent title and abstract screening, and 68 studies were then selected as eligible for full-text screening. Finally, 45 studies were involved in this review (n = 1580), and 24 of those were included in the quantitative analysis. The majority of the included RCTs had a low risk of bias regarding study reporting, participants' attrition, and generating a random sequence. Nearly half of the RCTs ensured good blinding of outcomes assessors. However, almost all the RCTs were unclear regarding the blinding of the participants and the study personnel. The 2020 retrospective cohort study conducted at Samsung Changwon Hospital, investigating the effects of virtual reality-based rehabilitation on upper extremity function in children with cerebral palsy, demonstrated fair quality in its methodology and findings. VR-assisted exergaming was more effective than conventional physiotherapy in improving the Gross Motor Function Measurement (GMFM)-88 score (MD = 0.81; 95% CI [0.15, 1.47], p-value = 0.02) and the GMFM walking and standing dimensions (MD = 1.45; 95% CI [0.48, 2.24], p-value = 0.003 and MD = 3.15; 95% CI [0.87, 5.42], p-value = 0.007), respectively. The mobility and cognitive domains of the Pediatric Evaluation of Disability Inventory score (MD = 1.32; 95% CI [1.11, 1.52], p-value < 0.001) and (MD = 0.81; 95% CI [0.50, 1.13], p-value < 0.0001) were also improved. The Canadian Occupational Performance Measure performance domain (MD = 1.30; 95% CI [1.04, 1.56], p-value < 0.001), the WeeFunctional Independence Measure total score (MD = 6.67; 95% CI [6.36, 6.99], p-value < 0.0001), and the Melbourne Assessment of Unilateral Upper Limb Function-2 score (p-value < 0.001) improved as well. This new intervention is similarly beneficial as conventional therapy in improving other efficacy measures. Conclusions: Our findings suggest that VR-assisted exergaming may have some advantages over conventional rehabilitation in improving CP children's functioning and performance in daily life activities, upper and lower limb mobility, and cognition. VR-assisted exergaming seems to be as effective as conventional physiotherapy in the other studied function measures. With its potential efficacy, better feasibility, no reported side effects, and entertaining experience, VR-assisted exergaming may be a viable complementary approach to conventional physiotherapy in rehabilitating children with CP.

PMID: 38002703

27. Resveratrol Reduces Neuroinflammation and Hippocampal Microglia Activation and Protects Against Impairment of Memory and Anxiety-Like Behavior in Experimental Cerebral Palsy

Caio Matheus Santos da Silva Calado, Raul Manhães-de-Castro, Sabrina da Conceição Pereira, Vanessa da Silva Souza, Leticia Nicoly Ferreira Barbosa, Osmar Henrique Dos Santos Junior, Claudia Jacques Lagranha, Pedro Alberto Romero Juárez, Luz Torner, Omar Guzmán-Quevedo, Ana Elisa Toscano

Mol Neurobol. 2023 Nov 25. doi: 10.1007/s12035-023-03772-3. Online ahead of print.

Cerebral palsy (CP) is a neurodevelopmental disorder characterized by motor and postural impairments. However, early brain injury can promote deleterious effects on the hippocampus, impairing memory. This study aims to investigate the effects of resveratrol treatment on memory, anxiety-like behavior, and neuroinflammation markers in rats with CP. Male Wistar rats were subjected to perinatal anoxia (P0-P1) and sensory-motor restriction (P2-P28). They were treated with resveratrol (10 mg/kg, 0.1 ml/100 g) or saline from P3-P21, being divided into four experimental groups: CS (n = 15), CR (n = 15), CPS (n = 15), and

CPR (n = 15). They were evaluated in the tests of novel object recognition (NORT), T-Maze, Light-Dark Box (LDB), and Elevated Plus Maze (EPM). Compared to the CS group, the CPS group has demonstrated a reduced discrimination index on the NORT ($p < 0.0001$) and alternation on the T-Maze ($p < 0.01$). In addition, the CPS group showed an increase in permanence time on the dark side in LDB ($p < 0.0001$) and on the close arms of the EPM ($p < 0.001$). The CPR group demonstrated an increase in the object discrimination index ($p < 0.001$), on the alternation ($p < 0.001$), on the permanence time on the light side ($p < 0.0001$), and on the open arms ($p < 0.001$). The CPR group showed a reduction in gene expression of IL-6 ($p = 0.0175$) and TNF-α ($p = 0.0007$) and an increase in Creb-1 levels ($p = 0.0020$). The CPS group showed an increase in the activated microglia and a reduction in cell proliferation in the hippocampus, while CPR animals showed a reduction of activated microglia and an increase in cell proliferation. These results demonstrate promising effects of resveratrol in cerebral palsy behavior impairment through reduced neuroinflammation in the hippocampus.

PMID: 38001357

28. Self-perception of dual career barriers and athletic identity in student-athletes with disabilities according to disability type and level of professionalization

M J Maciá-Andreu, R Vaquero-Cristóbal, L Meroño, L Abenza-Cano, J A García-Roca, F J Cánovas-Álvarez, A Díaz-Aroca, L Capranica, M Stanescu, A Pereira, M Doupona, F Mendes, A Figueiredo, E Isidori, A Sánchez-Pato, A Leiva-Arcas

Sci Rep. 2023 Nov 22;13(1):20531. doi: 10.1038/s41598-023-47881-4.

The objective of this study was to analyze the perceived barriers to dual career success and athletic identity of student-athletes according to disability type and level of professionalization. The final sample consisted of 203 student-athletes with disabilities from five European countries. The questionnaires used were ESTPORT, EBBS and AIMS. Depending on disability type, it was found that student-athletes with hearing and physical impairment showed the highest difficulty in reconciling sports and studies ($p = 0.001$); that student-athletes with a hearing impairment showed the highest score in the barrier 'the cost of education is high' ($p = 0.023$); that student-athletes with a physical impairment had the highest scores in the barrier 'Exercise tires me' ($p = 0.013$); that student-athletes with cerebral palsy showed the highest scores in the barrier 'I do not have enough university/educational institution support' ($p = 0.014$) and 'Exercise facilities do not have convenient timetables for me' ($p = 0.001$). Depending on sports professionalization level, semi-professional student-athletes showed the highest values in the barrier 'the university/educational institution is far from my training center' ($p = 0.040$); while professional student-athletes had the highest score in the barrier 'exercise takes too much time from family responsibilities' ($p = 0.034$). In most of the variables related to identity as athletes, professional student-athletes showed the highest values, followed by semi-professional athletes ($p = 0.043$-< 0.001). In conclusion, the self-perception of barriers is quite relevant, with differences arising from disability type and level of professionalization, whereas the identity as an athlete is only different according to the level of professionalization.

PMID: 37993589

29. Fine-needle percutaneous muscle microbiopsy technique as a feasible tool to address histological analysis in young children with cerebral palsy and age-matched typically developing children

Jorieke Deschrevel, Karen Maes, Anke Andries, Nathalie De Beukelaer, Marlies Corvelyn, Domiziana Costamagna, Anja Van Campenhout, Eva De Wachter, Kaat Desloovere, Anouk Agten, Frank Vandenabeele, Stefaan Nijs, Ghislaine Gayan-Ramirez

PLoS One. 2023 Nov 22;18(11):e0294395. doi: 10.1371/journal.pone.0294395. eCollection 2023.

Cerebral palsy (CP) is a heterogeneous group of motor disorders attributed to a non-progressive lesion in the developing brain. Knowledge on skeletal muscle properties is important to understand the impact of CP and treatment but data at the microscopic levels are limited and inconsistent. Currently, muscle biopsies are collected during surgery and are restricted to CP eligible for such treatment or they may refer to another muscle or older children in typically developing (TD) biopsies. A minimally invasive technique to collect (repeated) muscle biopsies in young CP and TD children is needed to provide insights into the early muscle microscopic alterations and their evolution in CP. This paper describes the protocol used to 1) collect microbiopsies of the medial gastrocnemius (MG) and semitendinosus (ST) in CP children and age-matched TD children, 2) handle the biopsies for histology, 3) stain the biopsies to address muscle structure (Hematoxylin & Eosin), fiber size and proportion (myosin heavy chain), counting of the satellite cells (Pax7) and capillaries (CD31). Technique feasibility and safety as well as staining feasibility and measure accuracy were evaluated. Two microbiopsies per muscle were collected in 56 CP (5.8±1.1 yr) and 32 TD (6±1.1 yr) children using ultrasound-guided percutaneous microbiopsy technique. The biopsy procedure was safe (absence of complications) and well tolerated (Score pain using Wong-Baker faces). Cross-sectionally orientated fibers were found in 86% (CP) and 92% (TD) of the biopsies with 60% (CP) and 85% (TD) containing more than 150 fibers. Fiber staining was successful in all MG biopsies but failed in 30% (CP) and 16% (TD) of the ST biopsies. Satellite cell staining was successful in 89% (CP) and 85% (TD) for MG and in 70% (CP) and 90% (TD) for ST biopsies, while capillary staining was successful in 88% (CP) and 100% (TD) of the MG and in 86% (CP) and 90% (TD) for the ST biopsies. Intraclass coefficient correlation showed reliable and reproducible measures of all outcomes. This study shows that the percutaneous microbiopsy technique is a safe and feasible tool to collect (repeated) muscle biopsies in young CP and TD children for histological analysis and it provides sufficient muscle tissue of good quality for reliable quantification.

PMID: 37992082

30. Neurodevelopment and physical measurements in infants with birthweight of 500 grams or less

Ryo Itoshima, Arata Oda, Ryo Ogawa, Toshimitsu Yanagisawa, Takehiko Hiroma, Tomohiko Nakamura

Pediatr Int. 2023 Jan-Dec;65(1):e15689. doi: 10.1111/ped.15689.

Background: In infants born weighing ≤500 g, little has been studied about the association between neurodevelopmental prognosis and growth. This study aimed to evaluate the association between neurodevelopmental impairment (NDI) and z-scores of physical measurements in infants born weighing ≤500 g. Methods: A single-center, retrospective cohort study in a level IV neonatal intensive care unit in Japan. Infants born weighing ≤500 g between 2010 and 2019 were eligible. Z-scores in weight, length/height, and head circumference at birth, due date (or discharge), 6 and 18 months of corrected age, and 3 years of age were compared between infants with and without NDI at 3 years of age. Three infants with severe intraventricular hemorrhage or periventricular leukomalacia were excluded from the comparison analyses. NDI was defined as having a developmental quotient of ≤70, cerebral palsy, visual impairment, or hearing impairment. Results: Of 22 eligible infants, the incidence of NDI at 3 years of age was 54.5%. The z-score was significantly smaller in the NDI group (n = 10) than that in the non-NDI group (n = 9) in head circumference at birth (median, -1.94 vs. -0.75; Z = 0.54; p = 0.020), and in height at 18 months of corrected age (median, -2.84 vs. -1.79; Z = 0.58; p = 0.013) and 3 years of age (median, -2.02 vs. -1.21; Z = 0.47; p = 0.046). Conclusions: NDI at 3 years of age was associated with a small head circumference z-score at birth, height at 18 months of corrected age, and height at 3 years of age in infants born weighing ≤500 g.

PMID: 37991183

31. Efficacy and safety of medical cannabinoids in children with cerebral palsy: a systematic review

Widya Murni, Tungki Pratama Umar, Kevin Tandarto, Abraham Simatupang, Armedy Ronny Hasugian, Reza Yuridian Purwoko, Sri Idaiani, Bella Stevanny, Caroline Oktarina, Reganedgary Jonlean, Tamara Tango, Kevin Surya Kusuma, Sagita Pratiwi Sugiyono, Aditya Putra

Einstein (Sao Paulo). 2023 Nov 17:21:eRW0387. doi: 10.31744/einstein_journal/2023RW0387. eCollection 2023.

Introduction: The increasing popularity of cannabinoids for treating numerous neurological disorders has been reported in various countries. Although it reduces tetrahydrocannabinol psychoactivity, it helps patients tolerate higher doses and complements the anti-spasmodic effects of tetrahydrocannabinol. One of the most important potential of cannabinoids are related to its potential to help children with cerebral palsy, a contributor of lifelong disability. Therefore, this systematic review aimed to assess the efficacy and safety of medical cannabinoids in children with cerebral palsy. Methods: This review adhered to The Preferred Reporting Items for Systematic Reviews and Meta-analysis 2020 guidelines. Seven databases, namely, Scopus, PubMed, EBSCO Host, ProQuest, Google Scholar, Semantic Scholar, and JSTOR, were used to identify relevant studies. Studies examining pediatric patients with cerebral palsy and reporting the efficacy and safety of medical cannabinoids through clinical trials, observational cross-sectional studies, or cohort designs were included. The outcomes of the studies included the efficacy of medical cannabinoids administered for spasticity, motor components, pain control, sleep difficulties, adverse effects, and seizure control. Results: Of 803 identified articles, only three met the inclusion criteria for data synthesis. One study exhibited a moderate risk-of-bias. A total of 133 respondents, mainly from Europe, were investigated. Overall effectiveness and safety were considered good. However, the results are inconsistent, especially regarding spasticity treatment variables. Conclusion: The anti-spasticity, anti-inflammatory, and anti-seizure properties of cannabinoids might be beneficial for patients with cerebral palsy, although their effectiveness has not been widely studied. Further studies with larger sample sizes and various ethnicities are warranted. Prospero database registration: (www.crd.york.ac.uk/prospero) under ID CRD42022358383.

PMID: 37991091

32. Academic skills in children with cerebral palsy and specific learning disorders

Serena Micheletti, Jessica Galli, Marika Vezzoli, Vera Scaglioni, Stefania Agostini, Stefano Calza, Lotfi B Merabet, Elisa Fazzi

Dev Med Child Neurol. 2023 Nov 21. doi: 10.1111/dmcn.15808. Online ahead of print.

Aim: To investigate the prevalence and clinical manifestations of reading, writing, and mathematics disorders in children with cerebral palsy (CP). We explored how the clinical profile of these children differed from those with specific learning disorders (SLDs), taking into account several factors, particularly IQ scores, neuropsychological aspects, and the presence of a visual impairment. Method: A prospective cross-sectional study was conducted in 42 children with CP (mean age 9 years 8 months;

SD = 2 years 2 months) and 60 children with SLDs (mean age 10 years; SD = 1 year 7 months). Clinical characteristics, neuromotor and cognitive profiles, neuropsychological aspects (speech performance, academic skills, visual attention, phonological awareness, working memory), and signs of visual impairment (visual acuity, contrast sensitivity, visual field, oculomotor functions) were assessed. A machine learning approach consisting of a random forest algorithm, where the outcome was the diagnosis and the covariates were the clinical variables collected in the sample, was used for the analyses. Results: About 59% of the children with CP had reading, writing, or mathematics disorders. Children with CP with learning disorders had a low performance IQ, normal phonological awareness, and working memory difficulties, whereas children with SLDs had normal performance IQ, impaired phonological awareness, and mild working memory difficulties. There were no differences in verbal IQ between the two groups. Interpretation: Learning disorders are frequently associated with CP, with different clinical characteristics, compared with SLDs. Assessment of academic skills is mandatory in these children, even if the IQ is normal. At school age, specific interventions to promote academic skills in children with CP could be a major rehabilitative goal.

PMID: 37990438

33. Validation study on a prediction formula to estimate the weight of children & adolescents with special needs aged 2-18 years old

Nurul Huda Ibrahim, Norasimah Kassim, Salimah Othman, Azahadi Omar, Norsuhaila Shaari, Anis Aslah Awiskarni, Norafidza Ashiquin Abdul Patah, Nabila Mohamed Nezuri, Maizatul Naqiah Zulfifli, Mohd Nadzrul Anuar Awang, Muhamad Farid Sani, Noorfadzlina Abdul Rashad, Siti Farhana Mesbah

J Health Popul Nutr. 2023 Nov 20;42(1):129. doi: 10.1186/s41043-023-00464-5.

Background: This study aims to validate two predictive formulas of weight estimating strategies in children with special needs, namely the Cattermole formula and the Mercy formula. Methodology: A cross-sectional study with a universal sampling of children and adolescents with special needs aged 2-18 years old, diagnosed with cerebral palsy, down syndrome, autism and attention-deficit/hyperactivity disorder was conducted at Community-Based Rehabilitation in Central Zone Malaysia. Socio-demographic data were obtained from files, and medical reports and anthropometric measurements (body weight, height, humeral length, and mid-upper arm circumference) were collected using standard procedures. Data were analysed using IBM SPSS version 26. The accuracy of the formula was determined by intraclass correlation, prediction at 20% of actual body weight, residual error (RE) and root mean square error (RMSE). Result: A total of 502 children with a median age of 7 (6) years were enrolled in this study. The results showed that the Mercy formula demonstrated a smaller degree of bias than the Cattermole formula (PE = 1.97 ± 15.99% and 21.13 ± 27.76%, respectively). The Mercy formula showed the highest intraclass correlation coefficient (0.936 vs. 0.858) and predicted weight within 20% of the actual value in the largest proportion of participants (84% vs. 48%). The Mercy formula also demonstrated lower RE (0.3 vs. 3.6) and RMSE (3.84 vs. 6.56) compared to the Cattermole formula. Mercy offered the best option for weight estimation in children with special needs in our study population.

PMID: 37986125

34. Qualitative differences in perspective on children's quality of life between children with cerebral palsy and their parents

Elena Swift, Lisa Gibbs, Dinah Reddihough, Andrew Mackinnon, Elise Davis

J Patient Rep Outcomes. 2023 Nov 20;7(1):118. doi: 10.1186/s41687-023-00656-x.

Background: Cerebral palsy (CP) is one of the most common childhood disabilities, impacting many areas of a child's life. Increasingly, quality of life (QOL) measures are used to capture holistic wellbeing of children with CP. However most validated QOL measures for children are based on adult perspective only, with limited focus on child perspective. Conceptual differences between children's and adults' definitions of QOL may reflect different underlying QOL models which contribute to measurement score divergence. This qualitative study investigated the conceptual meaning of QOL for children with CP, comparing child and parent perspectives. Eighteen families completed 8 child interviews and 18 parent interviews. Children (11 boys, 7 girls) represented the spectrum of motor functioning, with comorbidities including epilepsy, intellectual disability, and communication impairments. Child and parent interviews were analysed separately using constructivist grounded theory methods and then findings were integrated to examine similarities and differences. Results: All participants sought child inclusion in social activities, education, and recreation, requiring negotiation, adaptations, and advocacy. Five conceptual categories emerged from child interviews: socialising, play, negotiating limitations, self-identity, and developing agency. This reflected an individual model of QOL supporting child development goals. Parent interview findings revealed concepts related to child-specific QOL (day-to-day functioning and enabling child goals), as well as parent and family functioning concepts aligned to models of "family QOL", embracing impacts of family relationships and the interdependence of QOL among family members. Conclusions: This study identified similarities and differences in child and parent perceptions of QOL for the child with CP. Children provided insights into the importance of play and peer support, and their developing self-identity and sense of agency. Self-directed free play, especially, was identified by children but not parents as a central everyday activity

promoting wellbeing and social inclusion. Parents discussed family functioning and aspects outside of child sight, such as managing time and financial resources. Relying on parents' perspective alone to model child QOL misses valuable information that children contribute. Equally, child report alone misses parent experiences that directly influence child QOL. There is value in incorporating family QOL into parent reports while developing a conceptually separate child self-report QOL instrument.

PMID: 37982920

Prevention and Cure

35. Frontiers in the Etiology and Treatment of Preterm Premature Rupture of Membrane: From Molecular Mechanisms to Innovative Therapeutic Strategies

Ludan Xu, Tiantian Yang, Meiling Wen, Dawei Wen, Chaoyang Jin, Meiwen An, Li Wang, Yang Liu, Junmei Fan

Review Reprod Sci. 2023 Nov 21. doi: 10.1007/s43032-023-01411-9. Online ahead of print.

Preterm premature rupture of membranes (pPROM) poses a significant threat to fetal viability and increases the risk for newborn morbidities. The perinatal period of preterm infants affected by pPROM is often characterized by higher rates of mortality and morbidity, with associated risks of cerebral palsy, developmental delays, compromised immune function, respiratory diseases, and sensory impairments. pPROM is believed to result from a variety of causes, including but not limited to microbially induced infections, stretching of fetal membranes, oxidative stress, inflammatory responses, and age-related changes in the fetal-placental interface. Maternal stress, nutritional deficiencies, and medically induced procedures such as fetoscopy are also considered potential contributing factors to pPROM. This comprehensive review explores the potential etiologies leading to pPROM, delves into the intricate molecular mechanisms through which these etiologies cause membrane ruptures, and provides a concise overview of diagnostic and treatment approaches for pPROM. Based on available therapeutic options, this review proposes and explores the possibilities of utilizing a novel composite hydrogel composed of amniotic membrane particles for repairing ruptured fetal membranes, thereby holding promise for its clinical application.

PMID: 37989803

36. Neuroprotective Action of Tacrolimus before and after Onset of Neonatal Hypoxic-Ischaemic Brain Injury in Rats

Madeleine J Smith, Tayla Penny, Yen Pham, Amy E Sutherland, Graham Jenkin, Michael C Fahey, Madison C B Paton, Megan Finch-Edmondson, Suzanne L Miller, Courtney A McDonald

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(1) Background: Neonatal brain injury can lead to permanent neurodevelopmental impairments. Notably, suppressing inflammatory pathways may reduce damage. To determine the role of neuroinflammation in the progression of neonatal brain injury, we investigated the effect of treating neonatal rat pups with the immunosuppressant tacrolimus at two time points: before and after hypoxic-ischaemic (HI)-induced injury. (2) Methods: To induce HI injury, postnatal day (PND) 10 rat pups underwent single carotid artery ligation followed by hypoxia (8% oxygen, 90 min). Pups received daily tacrolimus (or a vehicle) starting either 3 days before HI on PND 7 (pre-HI), or 12 h after HI (post-HI). Four doses were tested: 0.025, 0.05, 0.1 or 0.25 mg/kg/day. Pups were euthanised at PND 17 or PND 50. (3) Results: All tacrolimus doses administered pre-HI significantly reduced brain infarct size and neuronal loss, increased the number of resting microglia and reduced cellular apoptosis ($p < 0.05$ compared to control). In contrast, only the highest dose of tacrolimus administered post-HI (0.25 mg/kg/day) reduced brain infarct size ($p < 0.05$). All doses of tacrolimus reduced pup weight compared to the controls. (4) Conclusions: Tacrolimus administration 3 days pre-HI was neuroprotective, likely mediated through neuroinflammatory and cell death pathways. Tacrolimus post-HI may have limited capacity to reduce brain injury, with higher doses increasing rat pup mortality. This work highlights the benefits of targeting neuroinflammation during the acute injurious period. More specific targeting of neuroinflammation, e.g., via T-cells, warrants further investigation.

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37. Human Umbilical Cord Mesenchymal Stem Cells Improve the Status of Hypoxic/Ischemic Cerebral Palsy Rats by Downregulating NogoA/NgR/Rho Pathway

Yaoling Luo, Jiayang Qu, Zhengyi He, Minhong Zhang, Zhengwei Zou, Lincai Li, Yuxian Zhang, Junsong Ye

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Human umbilical cord mesenchymal stem cells (hUCMSC) have shown promising potential in ameliorating brain injury, but

the mechanism is unclear. We explore the role of NogoA/NgR/Rho pathway in mediating hUCMSC to improve neurobehavioral status and alleviate brain injury in hypoxia/ischemia-induced CP (cerebral palsy) rat model in order to promote the clinical application of stem cell therapy in CP. The injury model of HT22 cells was established after 3 h hypoxia, and then co-cultured with hUCMSC. The rat model of CP was established by ligation of the left common carotid artery for 2.5 h. Subsequently, hUCMSC was administered via the tail vein once a week for a total of four times. The neurobehavioral status of CP rats was determined by behavioral experiment, and the pathological brain injury was determined by pathological staining method. The mRNA and protein expressions of NogoA, NgR, RhoA, Rac1, and CDC42 in brain tissues of rats in all groups and cell groups were detected by real-time quantitative polymerase chain reaction (RT-qPCR), Western blot, and immunofluorescence. The CP rats exhibited obvious motor function abnormalities and pathological damage. Compared with the control group, hUCMSC transplantation could significantly improve the neurobehavioral situation and attenuate brain pathological injury in CP rats. The relative expression of NogoA, NgR, RhoA mRNA, and protein in brain tissues of rats in the CP group was significantly higher than the rats in the sham and CP+hUCMSC group. The relative expression of Rac1, CDC42 mRNA, and protein in brain tissues of rats in the CP group was significantly lower than the rats in the sham and CP+hUCMSC group. The animal experiment results were consistent with the experimental trend of hypoxic injury of HT22 cells. This study confirmed that hUCMSC can efficiently improve neurobehavioral status and alleviate brain injury in hypoxia/ischemia-induced CP rat model and HT22 cell model through downregulating the NogoA/NgR/Rho pathway.

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