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Monday 02 June 2025

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Interventions and Management

Interventions and Management

1.A Multisite Randomized Controlled Trial of Hand Arm Bimanual Intensive Training Including Lower Extremity (HABIT-ILE) for Children with Bilateral Cerebral Palsy

Leanne Sakzewski, Yannick Bleyenheuft, Iona Novak, Catherine Elliott, Sarah Reedman, Catherine Morgan, Kerstin Pannek, Natalie Dos Santos, Ashleigh Hines, Sherilyn Nolan, Robert S Ware, Roslyn N Boyd

J Pediatr . 2025 May 27:114666. doi: 10.1016/j.jpeds.2025.114666. Online ahead of print.

Objective: To test the efficacy of Hand Arm Bimanual Intensive Therapy Including Lower Extremity (HABIT-ILE) to improve gross motor function, manual ability, goal performance, walking endurance, mobility, and self-care for children with bilateral cerebral palsy (CP).
Study design: This prospective, waitlist randomized controlled trial included children with bilateral CP, aged 6-to-16-years and classified Gross Motor Function Classification System (GMFCS) levels II to IV. HABIT-ILE delivered for 2 weeks (65 hours) was compared with usual care (UC). Primary outcomes post-intervention were gross motor function (Gross Motor Function Measure-66) and manual ability (ABILHAND-Kids). Secondary outcomes were goal performance (Canadian Occupational Performance Measure), self-care and mobility (Pediatric Evaluation of Disability Inventory-Computer Adapted Test), bimanual hand performance (Both Hands Assessment), and walking endurance (6 Minute Walk Test). Linear regression models were used to determine between group differences, adjusted for baseline scores.
Results: 92 children were recruited; two were deemed ineligible after randomization and were excluded. 90 children (HABIT-ILE n=46, UC n=44), mean age 10.4 (SD 3.0) years, GMFCS II=32; III=31; IV=27 were included. HABIT-ILE led to superior gains in manual ability (mean difference 0.85, 95% CI 0.38-1.33; P<0.001) but not gross motor function. HABIT-ILE led to superior changes on goal performance, self-care, and mobility.
Conclusions: HABIT-ILE was effective in improving manual ability, mobility, self-care, and goal performance, but not gross motor function. Significant gains immediately post-intervention were retained at 26 weeks. Large individual variability suggests further analyses need to be performed to understand characteristics of children who achieved clinically meaningful gains across outcomes.
PMID: 40441525

2.Cross-cultural adaptation and psychometric validation of the Greek version of Bimanual Fine Motor Function 2 for children with cerebral palsy

Vasileios C Skoutelis, Renata Moutsiou, Melpomeni Giorgi, Eirini Moysoglou, Vasileios Fragkakis, Georgia Chlouveraki, Pavlina Psychouli, Zacharias Dimitriadis, Argyrios Dinopoulos

Disabil Rehabil . 2025 May 30:1-8. doi: 10.1080/09638288.2025.2511287. Online ahead of print.

Purpose: To translate and culturally adapt the Bimanual Fine Motor Function 2 (BFMF-2) for use in Greece and assess its psychometric properties, focusing on interrater reliability and construct validity.
Methods: Translation and Cultural Adaptation: Conducted in six stages: forward-translation, synthesis, back-translation, expert committee review, pretesting, and final submission. Psychometric Validation: Assessed interrater reliability among a paediatric neurologist, physiotherapist, occupational therapist, and a parent per child. Convergent construct validity was evaluated using the Greek (Mini-)Manual Ability Classification System (MACS-GR).
Results: Translation and Cultural Adaptation: The process resulted in the development of the Greek BFMF-2 (BFMF-2-GR). Psychometric Validation: Included 62 children with cerebral palsy (CP) aged 3-8 years (mean age 6.2). The overall interrater reliability among four raters was excellent, with an intraclass correlation coefficient up to 0.95. Pairwise interrater reliability ranged from substantial to almost perfect, with Cohen's weighted kappa coefficient from 0.74 to 0.96. Convergent construct validity showed a positive correlation between the BFMF-2-GR and the (Mini-)MACS-GR, with Spearman's ρ from 0.89 to 0.94.
Conclusions: The BFMF-2-GR is a clear, practical, reliable, and valid tool for classifying the fine motor capacity of children with CP in Greece, specifically their ability to grasp, hold, and manipulate objects with each hand separately.
Plain language summary
The Bimanual Fine Motor Function 2 (BFMF-2) is a simple, practical scale for fine hand use in children with cerebral palsy, enabling quick and easy evaluation of each hand’s function separately. The Greek BFMF-2 shows excellent interrater reliability and strong construct validity. The Greek BFMF-2 is now available and suitable for clinical and research purposes.
PMID: 40445206

3.Ultrasound-Guided Botulinum Toxin Injections for Hand Spasticity: A Technical Guide for the Dorsal Approach

Calogero Malfitano, Antonio Robecchi Majnardi, Arianna Pesaresi, Vincenzo Ricci

Toxins (Basel) . 2025 May 3;17(5):225. doi: 10.3390/toxins17050225.

Abstract
Spasticity often occurs following neurological disorders such as traumatic brain injury, cerebral palsy, and stroke. Botulinum toxin (BTX) injections, especially when paired with rehabilitation, are among the most effective interventions for these patients. Various techniques for administering BTX injections to the upper limb muscles have been described. However, a standardized method for ultrasound-guided injections in the intrinsic muscles of the hand remains quite scant in the literature. The authors suggest a novel dorsal approach to treat the most common abnormal postural patterns in hand spasticity, thumb-in-palm, and intrinsic plus. This approach facilitates access to the muscles while minimizing patient discomfort, as it avoids the need to open forcibly the spastic hand. The adductor pollicis, flexor pollicis brevis, lumbrical, and interosseus muscles have been identified as primary anatomical targets to improve hand posture and function. Standardized sonographic scans are leveled with anatomical illustrations and probe/patient positioning images for interventional procedures. Additionally, tips and techniques for promptly identifying vascular bundles are included to enhance the safety of the procedures. This technical report aims to provide an easy and ready-to-use tool in clinical practice for injecting intrinsic hand muscles in spastic patients, utilizing a novel dorsal approach.
PMID: 40423308

4.Validity and Reliability of the Turkish Version of the Shriners Hospital Upper Extremity Evaluation in Children With Hemiplegic Cerebral Palsy

Gokcen Akyurek, Gonca Bumın, Medine Nur Özata Değerli, Ahmet Metin Özsezen, Cemil Yıldız

Child Care Health Dev . 2025 Jul;51(4):e70101. doi: 10.1111/cch.70101.

Background: The Shriners Hospital Upper Extremity Evaluation (SHUEE) is a video-based tool designed to assess spontaneous functional analysis, dynamic positional analysis and grasp and release abilities in children with various diagnoses. The aim of this study is to evaluate the validity and reliability of the Turkish version of SHUEE in children with hemiplegic cerebral palsy (CP).
Methods: The study included 23 children with hemiplegic CP, aged 6-15 years. The reliability of the scale was assessed using intraclass correlation coefficients (ICCs) for inter-rater reliability and Cronbach's alpha for internal consistency. Hypothesis testing for construct validity was assessed using the Children's Hand-Use Experience Questionnaire (CHEQ) and ABILHAND-Kids, comparing SHUEE scores based on gender and the affected side.
Results: The inter-rater reliability of SHUEE was found to be excellent, with ICC values ranging from 0.927 to 0.981. Cronbach's alpha was 0.759 for the total SHUEE score. Hypothesis testing for construct validity of SHUEE was confirmed through significant correlations with CHEQ and ABILHAND-Kids ($p < 0.05$). Also, the analyses showed no significant differences in SHUEE scores based on gender or the affected extremity ($p > 0.05$).
Conclusion: The Turkish version of SHUEE has been demonstrated to be a valid and reliable assessment tool. This study supports SHUEE's effectiveness as both a clinical and scientific measurement tool.
PMID: 40435401

5.Start-Up of Rhizotomy Program in a Developing Country

Tufan Hiçdönmez

Adv Tech Stand Neurosurg . 2025:51:239-244. doi: 10.1007/978-3-031-86441-4_17.

Abstract
The selective dorsal rhizotomy (SDR) procedure is an efficient surgical treatment of spasticity in children with cerebral palsy. My training background of pediatric neurosurgery at the British Columbia's Children's Hospital, an experienced center for spasticity, allowed me to contribute to the start-up of the rhizotomy program in Ulaanbaatar, Mongolia, in September 2022. Five spastic children with cerebral palsy with GMFCS levels 2-4 were chosen for the first SDR procedures. Intensive physiotherapy and rehabilitation program were given to children after SDR. After 6 months, early results were satisfactory. My personal experience of performing first SDR surgeries in another country is that the minimum of a SDR surgery team consists of a neurosurgeon, an electrophysiology technician responsible for selection of nerve rootlets, and an anesthesiologist. The physiotherapist responsible for patient selection and rehabilitation follow-up and rehabilitation facilities and family support are essential.
PMID: 40445352

6.Patient Selection in Selective Dorsal Rhizotomy (SDR)

Benjamin J Hall, Conor S Gillespie, Christine Sneade; Alder Hey Children’s Hospital Physiotherapy Group; Deborah Quirk, Dawn Hennigan, Benedetta Pettorini

Review Adv Tech Stand Neurosurg . 2025:51:225-237. doi: 10.1007/978-3-031-86441-4_16.

Abstract
For almost as long as selective dorsal rhizotomy (SDR) has existed, there has been debate surrounding which patients should be eligible to undergo the procedure. The selection criteria used to identify suitable surgical candidates have remained largely unchanged for the last three decades, despite the popularity and use of the procedure increasing. Historically, those aged between 3 and 9 years, those of GMFCS level 2 or 3, and those without evidence of dystonia were considered for SDR. In recent years, as the procedure has continued to develop, however, these parameters are expanding, with evidence to suggest a much broader cohort of patients may benefit from SDR than once thought. This chapter seeks to review current practice in patient selection for SDR, as well as the potential directions that this controversial discussion may move towards in the future.
PMID: 40445351

7.Long-Term Outcome of Selective Dorsal Rhizotomy for Spastic Children

Nelleke G Langerak, Berendina E Veerbeek, Robert P Lamberts

Review Adv Tech Stand Neurosurg . 2025:51:209-222. doi: 10.1007/978-3-031-86441-4_15.

Abstract
Given the concerns associated with the ageing process in adults with cerebral palsy (CP) and the significant number of children who have undergone selective dorsal rhizotomy (SDR) in the recent decades, there is an important clinical need to evaluate both the short- and long-term impacts of this invasive and irreversible neurosurgical procedure. To gain insight in the health condition, the International Classification of Functioning, Disability and Health (ICF) model was used. The ICF serves as a biopsychosocial model for evaluating individuals with disabilities, providing a comprehensive perspective that encompasses understanding both the 'body structure and function' of individuals and determining the level of 'activity and participation' within the community. Furthermore, this review incorporates the dimension 'quality of life' as an essential factor to be discussed in relation to the outcomes of SDR. Based on a narrative literature review, this chapter outlines the outcomes observed at 5-15 years and 15-25 years post-SDR. Additionally, insights into outcomes beyond 25 years after SDR have been provided, drawing on the experiences of the Cape Town research group in South Africa, where SDR was reintroduced on a large scale by Warwick Peacock in the 1980s. The chapter concludes with a discussion on complications following SDR. This review will provide the clinical community and parents with information about the short- and long-term outcomes of this neurosurgical intervention.
PMID: 40445350

8.Postoperative Functional Recovery and Rehabilitation Following Selective Dorsal Rhizotomy

Neil Wimalasundera

Review Adv Tech Stand Neurosurg . 2025:51:193-208. doi: 10.1007/978-3-031-86441-4_14.

Abstract
Selective dorsal rhizotomy (SDR) has been practiced for many years; however, standardization of processes such as the surgical technique and rehabilitation protocols are only relatively recent phenomenon. Comparing data from various studies can be limited due to temporal changes in practice, different selection criteria for SDR, the heterogeneity of cerebral palsy and variable rehabilitation protocols. This chapter reviews the available evidence in relation to best practice for rehabilitation following SDR and explores factors affecting the short- and long-term outcome following SDR. This includes more easily measurable factors, such as the child's preoperative Gross Motor Function Measurement (GMFM) and severity of spasticity, to social and cognitive factors which can affect participation in rehabilitation.
PMID: 40445349

9.Selective Dorsal Rhizotomy: What, When, and Why to Cut

Federico Bianchi, Giuliano Di Monaco 2, Gianpiero Tamburrini

Review Adv Tech Stand Neurosurg . 2025:51:165-171. doi: 10.1007/978-3-031-86441-4_12.

Abstract
Selective dorsal rhizotomy represents one of the major neurosurgical tools in treating pediatric spasticity. Intraoperative rootlet selection is the key step of the procedure in order to achieve good outcomes. Intraoperative monitoring (IOM) and anatomical selection of the rootlets are the gold standard in the aforementioned selection leading the surgeon during the procedure. The tendency toward minimally invasive procedures further increases IOM importance, warranting the use of electrophysiology in choosing the more suitable rootlets for cutting. Discharge pattern and percentage of resection represent the most important topics in surgical guidance, relying onto the very same pathophysiological mechanism causing spasticity to choose targets.
PMID: 40445347

10.Dorsal Rhizotomy at the Intradural Juxtaforaminal Zone

George Georgoulis, Anthony Joud, Marc Sindou

Review Adv Tech Stand Neurosurg . 2025:51:139-163. doi: 10.1007/978-3-031-86441-4_11.

Abstract
To optimize the efficacy of dorsal rhizotomy (DRh) in treating spasticity associated with cerebral palsy, the authors advocate for individual access (intradurally) to all roots from L2 to S2. The initial step involves the use of electrical stimulation of the ventral root (VR) to confirm their anatomical identity and determine their corresponding myotomal territory of innervation, which is known to exhibit interindividual variability (anatomical mapping). The primary objective is then to employ dorsal root (DR) stimulation to assess their respective reflexive excitability levels (physiological testing). To mitigate the risk of spine destabilization, access is gained through enlarged interlaminar openings while preserving the spinous processes and interspinous ligaments. This approach is termed Keyhole Interlaminar Dorsal rhizotomy (KIDr). Intradural access to the roots is achieved at their preforaminal zone, through a L1-L2 opening for the L2 and L3 roots, L3-L4 opening for the L4 and L5 roots, and L5-S1 opening for the L5 and S1 roots. Under microsurgical visualization, at each exposed root level, the VR is stimulated to verify its myotomal distribution, and the DR is stimulated to estimate the segmental reflexive excitability using Fasano's grading system, allowing for the adjustment of the number of rootlets per root to be severed. In our practice, indications are primarily based on the Gross Motor Function Classification System (GMFCS): for individuals classified as levels III and IV, the goal is to enhance functional status and prevent or halt deformities; for those at level V and quadriplegic patients, the aim is to improve comfort, reduce pain, facilitate care, and alleviate upper limb disability through the "distant effects" often observed following lumbo-sacral rhizotomy. The timing of surgery is determined not only by age-related locomotor development but also by the plateau or deterioration of the Gross Motor Function Measure (GMFM) curve despite intensive rehabilitation efforts. As with all specialized centers, the surgical schedule is established in collaboration with a multidisciplinary team and documented in a comprehensive chart, alongside the Gain Attainment project.
PMID: 40445346

11.Rootlet Selection by Crescendo Single-Pulse Evoked Compound Muscle Action Potential Interpretation During Selective Dorsal Rhizotomy

Bo Xiao

Adv Tech Stand Neurosurg . 2025:51:123-138. doi: 10.1007/978-3-031-86441-4_10.

Abstract
Selective dorsal rhizotomy (SDR) is a surgical intervention aimed at reducing spasticity in children with cerebral palsy. This chapter introduces an innovative approach to SDR, utilizing crescendo single-pulse evoked compound muscle action potential (CMAP) interpretation for rootlet selection. The method combines preoperative spastic muscle identification, intraoperative neurophysiological monitoring, and a precise stimulation protocol to guide the selective sectioning of sensory nerve roots. The chapter outlines the setup for crescendo single-pulse stimulation-guided SDR, including preoperative muscle group identification, intraoperative monitoring channels, and surgical approach. It details the stimulation protocol and defines criteria for motor nerves, sphincter-associated sensory nerves, and lower limb-associated sensory nerves based on evoked CMAP patterns. The concept of a "rhizotomy ratio" is introduced as a potential metric correlating with the severity of the patient's condition. Midterm outcomes of this approach are presented, based on a cohort of 481 cases with a minimum 2-year follow-up across all 5 levels of the Gross Motor Function Classification System (GMFCS). Results show muscle tone decreased by an average of 1.0 level in spastic muscle groups immediately after surgery, with a tendency to continue reducing by an additional 0.8 level in the following 2 years post-SDR. Motor function improved significantly, with 39.1% of patients advancing by one or two GMFCS levels (in 432 cases with preop GMFCS levels II-V), concurrent with intensive rehabilitation programs. The greatest improvements were observed in children who underwent surgery before age six and those with less severe preoperative motor impairments. The chapter also discusses postoperative rehabilitation strategies tailored to the gradual reduction in muscle tone experienced by children following SDR. Gait analysis in mild cases indicates improved walking patterns post-SDR. Overall, this crescendo single-pulse stimulation-guided SDR approach demonstrates promising outcomes in reducing spasticity and improving motor function in children with cerebral palsy, with minimal complications reported.
PMID: 40445345

12.Preoperative Assessments for Selective Dorsal Rhizotomy

Olivia Shien Hui Lee

Review Adv Tech Stand Neurosurg . 2025:51:81-96. doi: 10.1007/978-3-031-86441-4_7.

Abstract
Selective dorsal rhizotomy (SDR) in cerebral palsy care aims to improve gait and function in ambulatory children and enhance comfort in nonambulatory children. This assessment and planning process for SDR requires a multidisciplinary team to work closely with patients and families to weigh the benefits and risks of SDR. Preoperative assessments allow the clinical team to select suitable candidates, set realistic goals, and optimise outcomes. These evaluations include physical measures, assessment of gross motor function and functional daily living skills, and gait analysis to better quantify the impact of spasticity in the SDR candidate. Further orthopaedic evaluations are required to identify pain and musculoskeletal issues, guiding subsequent post-SDR interventions. Additionally, assessments of quality-of-life assessments ensure a comprehensive rehabilitation plan that includes psychosocial support. This chapter discusses the comprehensive preoperative rehabilitation assessments that assist clinicians and families in making shared decisions about SDR.
PMID: 40445342

13.Selection of Children with Spasticity Other Than Cerebral Palsy: Indications, Long-Term Outcome, and Exclusion Criteria

Pramath Kakodkar, Nooshin Shekari, Madhura Thipse, Debajyoti Datta, Albert Tu

Adv Tech Stand Neurosurg. 2025:51:65-80. doi: 10.1007/978-3-031-86441-4_6.

Background: Selective dorsal rhizotomy (SDR) has been instrumental in improving functionality and mitigating lower extremity spasticity originating from a myriad of central nervous system (CNS) etiologies. Existing literature on SDR extensively discusses its utility in cerebral palsy (CP)-associated spasticity management. There is a void on the utility and guidance in patient selection for SDR in pediatric patients with non-CP-related spasticity.
Methods: A systematic review was performed on studies describing SDR outcomes in pediatric patients identified from Medline and Embase databases. Publications between January 1970 and August 2023 were included. Combinations of search terms "selective dorsal rhizotomy," "selective posterior rhizotomy," and "spasticity" were utilized. Pediatric patient studies with clinical data on spasticity, ambulation, procedural variables, and follow-up outcomes were included. Articles including patients without cerebral palsy as a primary diagnosis were reviewed in detail for outcomes after intervention.
Results: A total of 114 publications were identified, and of these, 11 fit inclusion criteria for a total of 127 patients. Most common non-CP etiologies for spasticity included hereditary spastic paraparesis (27.8%, n = 34), congenital syndrome (n = 7), and spinal cord injury (21.9%, n = 6). Compared to their baseline, SDR in non-CP-related etiologies demonstrated tone normalization (93%, n = 43 out of 45 patients) in most and improvement in ambulation (49.2%, n = 58 out of 118 patients) in a significant proportion of patients.
Conclusion: This systematic review on SDR in pediatric patients revealed effective spasticity control and improvement in ambulatory functionality in selected patients without cerebral palsy. Appropriate patient selection is keystone in achieving sustained benefits in functionality and quality of life.
PMID: 40445341

14.Creating a Selective Dorsal Rhizotomy Team

Benjamin J Hall, Conor S Gillespie, Christine Sneade; Alder Hey Children's Hospital Physiotherapy Group; Deborah Quirk, Dawn Hennigan, Benedetta Pettorini

Review Adv Tech Stand Neurosurg . 2025:51:53-63. doi: 10.1007/978-3-031-86441-4_5.

Abstract
Selective dorsal rhizotomy (SDR) is becoming increasingly popular in the management of spasticity in children. Spasticity itself is a multifaceted clinical entity that requires a holistic approach in order to effectively care for and improve the quality of life of those affected. To deliver these goals, a broad multidisciplinary team is required. From the role of neurosurgery in undertaking the procedure, through to the comprehensive rehabilitation process supported by physiotherapy, this chapter aims to summarise the key features necessary for an SDR unit to succeed as a team when providing care to their patients.
PMID: 40445340

15.Role of Dorsal Rhizotomy in the Comprehensive Management of Childhood Spasticity

Nobuhito Morota

Review Adv Tech Stand Neurosurg . 2025:51:43-52. doi: 10.1007/978-3-031-86441-4_4.

Abstract
Spasticity, characterized by muscle hypertonia, in children poses long-term challenges, leading to motor dysfunction, joint contractures, and a decline in overall quality of life (QOL). This underscores the critical need for effective spasticity management in disabled children. Various interventions, including oral medications, neurorehabilitation, and surgical procedures, have been used in the management of childhood spasticity. Dorsal rhizotomy, a neurosurgical intervention, plays a vital role in this context, selectively and functionally severing roots/rootlets to manage spasticity. Treatment modalities for spasticity encompass basic and active management, with interventions like dorsal rhizotomy, intrathecal baclofen infusion (ITB), and local injection of botulinum toxin (BTX). A strategic approach involves a "spasticity first" policy, prioritizing spasticity reduction, followed by active management and functional improvement through neurorehabilitation and orthopedic surgery. Comparative assessment of treatments, considering factors like age and joint involvement, guides the selection of interventions. Dorsal rhizotomy stands out for its sustainable and cost-effective reduction of spasticity, offering broad applicability across severity levels and diverse pathologies. Despite its efficacy, dorsal rhizotomy has limitations, including its invasiveness, irreversible nature, and the need for postoperative lifelong neurorehabilitation. Careful patient selection by a multidisciplinary spasticity clinic is crucial. The procedure's distinctive role, effectiveness, and cost-effectiveness place dorsal rhizotomy as a valuable tool in comprehensive childhood spasticity management.
PMID: 40445339

16.Neurophysiological and Neuroanatomical Background of Spasticity: Surgical Implication for Dorsal Rhizotomy in Cerebral Palsy

Marc Sindou, Anthony Joud, George Georgoulis

Review Adv Tech Stand Neurosurg . 2025:51:15-39. doi: 10.1007/978-3-031-86441-4_3.

Abstract
Spasticity arises from the exaggeration of the monosynaptic reflex, attributed to the loss of inhibitory influences from descending supraspinal structures, though not exclusively. Defined by its resistance to muscle stretching, spasticity yields two significant outcomes. Firstly, muscles tend to remain in a shortened position, restricting movement. Secondly, hypertonia, coupled with a lack of mobilization, leads to soft tissue changes, including a loss of viscoelasticity. This non-velocity-dependent biomechanical aspect limits movements, even at slow velocities, rendering them unresponsive to antispastic agents. Proactively addressing hypertonia/spasticity is crucial to prevent the fixation of disorders and the potential irreducibility of this vicious circle. Understanding the role of the reticular formation, its afferent projections, and efferent pathways is essential for comprehending circadian tone variations and the variability in clinical presentations among patients. The mechanism of hypertonia in children with cerebral palsy is twofold: a neural component due to spasticity (velocity dependent) and a biomechanical component linked to soft tissue changes. Although clinically challenging to differentiate, this distinction is crucial, as only the former responds to antispastic treatments, while the latter requires physiotherapy. Additionally, spasticity is often accompanied by dystonia, a sustained hypertonic state induced by voluntary motion attempts. Distinguishing spasticity from dystonia is essential, as dorsal rhizotomy minimally affects the dystonic component. Spasticity, by opposing muscle stretching and lengthening, leads to muscles remaining in a shortened position, resulting in soft tissue changes and contracture, ultimately restricting movements. Hypertonia and lack of mobilization create a vicious circle, culminating in severe locomotor disability due to irreducible musculotendinous retraction and joint ankylosis/bone deformities. These evolving consequences must be carefully considered during a child's assessment for decision-making. The hypotonic effects of lumbosacral dorsal rhizotomy, acting not only at a segmental level on the lower limbs but also supra-segmentally through the reticular formation, are also discussed.
PMID: 40445338

17.Introduction

Nobuhito Morota, Paul Steinbok

Review Adv Tech Stand Neurosurg . 2025:51:1-2. doi: 10.1007/978-3-031-86441-4_1.

Abstract
In this chapter, the current status of dorsal rhizotomy is reviewed, highlighting its significant evolution over the past four decades. The first major advancement was sparked by Fasano's introduction of intraoperative neurophysiological procedures and Peacock's modification of the surgical site to the cauda equina. Subsequent advancements in surgical and neurophysiological techniques have expanded the indications for rhizotomy beyond spastic cerebral palsy, a condition affecting 0.2% of live births worldwide. Dorsal rhizotomy can significantly benefit children with spasticity by improving their mobility, daily activities, and social participation.
PMID: 40445336

18.Hip reconstruction surgery combined with contralateral guided growth in cerebral palsy patients: preliminary results of a novel approach

María Galán-Olleros, María Jesús Figueroa-Gatica, Ana Ramírez-Barragán, Manuel Fraga-Collarte, Carmen Martínez-González, Hugo Garlito-Díaz, Ignacio Martínez-Caballero

Observational Study J Pediatr Orthop B . 2025 Jul 1;34(4):309-314. doi: 10.1097/BPB.0000000000001240. Epub 2025 May 27.

Abstract
Hip dislocation is a common and severe complication in children with cerebral palsy (CP), significantly affecting their quality of life. In cases of unilateral hip dislocation, there is ongoing debate regarding the choice between unilateral versus bilateral reconstructive surgeries. This study explores an alternative approach that combines unilateral hip reconstruction surgery with contralateral Proximal Femoral Guided Growth (PFGG) as a potential solution. A retrospective observational study was conducted at a pediatric neuro-orthopedic referral center from 2019 to 2022, including children who underwent hip reconstruction surgery and contralateral PFGG. The minimum follow-up period was 2 years. Collected data included demographic, clinical, and surgical details, radiological parameters, as well as complications. Eleven patients (six females and five males) with varying levels of functional impairment (2 Gross Motor Function Classification System level III, 4 level IV, and 5 level V) were included. The median age at surgery was 7.7 years (range: 4.9-11 years), with a median follow-up period of 29.6 months (range: 24.1-55.6 months). Significant improvements were observed in all parameters for the reconstructed hip and in several parameters for the PFGG-treated hip, particularly migration percentage, head-shaft angle, and Hilgenreiner epiphyseal angle ($P < 0.05$). Reconstructed hips had significantly more complications than those treated with PFGG(13 versus 2, $P < 0.001$). Combining hip reconstruction surgery with contralateral PFGG offers a promising alternative to traditional bilateral reconstructive procedures when managing unilateral hip dislocation in CP patients. This approach not only addresses the immediate hip dislocation but also prevents future contralateral hip displacement within the same surgical session, while minimizing complication rates. Further studies are needed to validate these findings and establish comprehensive guidelines for this surgical strategy. Level of evidence: Level IV, case series.
PMID: 40439061

19.The effect of traditional Thai massage vs routine physical therapy on gait pattern in spastic cerebral palsy: A cross-over randomized controlled trial

Peerapat Lertwiram, Chanika Angsanuntsukh, Krongkaew Supapitanon, Tanyaporn Patathong, Apiphan Iamchaimongkol, Suchanont Baosuwan, Ponsaphat Ongtanasin, Phimpisut Srinorasit, Patarawan Woratanarat

Randomized Controlled Trial PLoS One . 2025 May 29;20(5):e0325169. doi: 10.1371/journal.pone.0325169. eCollection 2025.

Background: Various types of massage, including the traditional Thai, have not yet provided conclusive evidence to reduce the spasticity and improve walking ability for cerebral palsy (CP).
Objectives: To assess the effect of traditional Thai massage (TM) vs. a standard physical therapy (PT) on gait pattern in spastic CP.
Methods: A cross-over single blinded randomized controlled trial was conducted between October 2022 and October 2023 (Thai Clinical Trials Registry: TCTR20220530007). Individuals with aged 5 years or older, and diagnosed as spastic CP, Gross Motor Function Classification System (GMFCS) I-III were recruited. Participants were randomly assigned into group A (TM followed by PT), and group B (PT followed by TM). Each treatment lasted for 6 weeks (Phase I-II), with a 6-week washout period. Lower extremity range of motion, muscle tone, electromyography, gait profile score (GPS), oxygen consumption was blindly assessed and intention-to-treat analyzed.
Results: From 32 eligible patients (16 cases per group), average age was 16.1 ± 9.8 years (group A), and 13.6 ± 5.8 years (group B). Group B demonstrated higher left ankle dorsiflexion than group A (1.7 ± 13.0 degrees vs 12.1 ± 6.9 degrees, P-value = 0.011). GPS slightly improved in Phase I, and contradictory enhanced in TM while deteriorated in PT in Phase II without significant differences between groups. After adjusted for ankle dorsiflexion, TM significantly provided less overall GPS (-1.6 (95% confidence interval (CI) -2.6, -0.6), P-value = 0.001), and higher peak activity of right rectus femoris (0.132 mV (95%CI 0.001, 0.262), P-value = 0.030) compared to PT. Other outcomes did not differ significantly between two treatments, and no complication was detected.
Conclusions: TM has a positive effect on gait performance, as indicated by GPS and increased activity in the right rectus femoris muscle when compared to PT. A large-scale non-inferiority trial is required to affirm the impact of TM.
PMID: 40440620

20.Comparison of the Hara, Harrington, and Davis hip joint center regression equations for gait analysis in children with cerebral palsy

Reiko Hara, Tishya A L Wren

Clin Biomech (Bristol) . 2025 May 20:126:106565. doi: 10.1016/j.clinbiomech.2025.106565. Online ahead of print.

Abstract
Background: Regression equations have been widely accepted in defining the location of the hip joint center in clinical gait analysis. Equations by Hara et al. require a single anthropometric measurement of leg length, allowing easy implementation in a clinical setting. This study evaluated the regression equations by Hara et al. in comparison to common equations by Harrington et al. and Davis et al. for clinical gait analysis in children with cerebral palsy.
Methods: The location of the hip joint centers was defined by each of the aforementioned three models and compared for retrospective gait analysis data of 30 children with cerebral palsy (13 females, age 5-16 years). Gait kinematics at the hip and knee across those models were further compared.
Findings: The location of the Hara hip joint center was defined in between the other two models: ~1 cm anterior and medial with almost the same height as Harrington's model. Gait kinematics reflected the location of the hip joint centers, placing the curves from the Hara model in between the others. The root mean square differences between the Hara and the other models were within 2.6 degrees in all planes of motion.
Interpretation: The regression equations by Hara et al. demonstrated similarity in the location of the hip joint center and gait kinematics to other common equations. The Hara model is simple, appears less susceptible to errors associated with soft tissue, and might be a good alternative option for clinical gait analysis in children with cerebral palsy.
PMID: 40414162

21.Muscle fascicle length adaptations to high-velocity training in young adults with cerebral palsy

Tessa L Gallinger, Brian R MacIntosh, Jared R Fletcher

Front Sports Act Living . 2025 May 13:7:1558784. doi: 10.3389/fspor.2025.1558784. eCollection 2025.

Introduction: In individuals with Cerebral Palsy (CP), both muscle cross-sectional area and fascicle length are reduced, contributing to decreased muscle strength, muscle shortening velocity and muscle mechanical power output, particularly in the plantarflexor muscles. A proposed mechanism to target increased muscle mechanical power output is to incorporate high velocity training (HVT) in these individuals, to increase fascicle length via sarcomerogenesis. To determine the effects of HVT on changes in MG muscle fascicle length and that impact on changes to MG muscle force-length-velocity-power characteristics in young adults with CP.
Methods: 12 young adults with CP (GMFCS I or II, 22.8 ± 6.0 years) were randomly allocated (some crossover) to no training (CP-NT, n = 8), or training (CP-T, n = 8). 10 recreationally trained healthy adults (HA, 22.5 ± 2.8 years) served as controls. CP -T performed 10-week training of biweekly sessions consisting of progressive intensity 10 m sprints, plyometrics and agility tasks. Triceps surae muscle force-power-velocity relationships were quantified with isokinetic dynamometry and ultrasound imaging. Data are expressed relative to pre-intervention values.
Results: HVT resulted in a significant increase in fascicle length in CP-T (+1.92 ± 3.21 mm, $p < 0.005$) compared to a significant decrease in CP-NT (-1.63 ± 3.00 mm, $p < 0.013$). While HVT did not result in significant changes in maximal shortening velocity (Vmax) or maximal peak power output (Pmax), a large effect size for vmax following training in CP-T was seen (+45.2 ± 76.4%, d = 0.909, p = 0.452), in contrast to CP-NT (+2.9 ± 70.5%, d = 0.059, p = 1.00). HVT also resulted in a very large effect for Pmax in CP-T (+35.0 ± 49.1%, d = 1.093, p = 0.232), but only a small effect was observed in CP-NT (+7.8 ± 49.1%, d = 0.245, p = 1.00). HA had significantly greater Pmax ($p < 0.001$), longer resting and active fascicle lengths ($p < 0.001$) and greater muscle force ($p < 0.001$), compared to CP-T.
Discussion: HVT is a feasible training intervention to increase triceps surae muscle fascicle length in individuals with CP. HVT can partially mitigate losses in Pmax in CP compared to healthy adults. Longer HVT programs may be required to increase muscle mechanical power output in CP to levels observed in HA.
PMID: 40433561

22.Match Demands and Perceived Exertion of Cerebral Palsy Soccer National Team Players

Daniel Wartner, Rick Cost, J C Andersen, José M Oliva-Lozano

Sports Health . 2025 May 30:19417381251338801. doi: 10.1177/19417381251338801. Online ahead of print.

Background: The aims of this study were to analyze match demands and perceptual responses of cerebral palsy soccer national team players. Specifically, to identify whether variations in match demands exist between playing positions and between halves.
Hypothesis: Differences between playing positions exist and match demands differ from first to second half.
Study design: Cohort study.
Level of evidence: Level 3.
Methods: An observational, longitudinal study was conducted over the 2022-2023 season. Electronic performance and tracking systems collected physical output, whereas perceptual responses were collected through ratings of perceived exertion postmatch.
Results: Playing position significantly affected all variables ($F(4,66) = 4.05\text{-}73.31$; $P < .001$; $\eta p2 = 0.20\text{-}0.82$). Midfielders had the greatest average physical output in all variables, except for high-intensity accelerations per minute (forwards = ~0.19 count/min) and maximum velocity (full-backs = ~28.87 km/h). Match half had no significant effect on any variable ($F(4,66) = 0.00\text{-}1.38$; $P > .05$; $\eta p2 = 0.00\text{-}0.02$), except for distance per minute, which was usually greater in the first half than second half ($F(1,66) = 7.15$; $P = .01$; $\eta p2 = 0.10$). Regarding perceptual response, playing position had a significant effect, with goalkeepers having significantly lower ratings of perceived exertion compared with the other positions ($P < .05$).
Conclusion: Playing position significantly affected all variables, with goalkeepers showing the lowest demands, followed by central defenders. Midfielders had the highest physical output across most variables, except for high-intensity accelerations per minute (forwards) and maximum velocity (full-backs). Match half had no significant effect on any variable, except for distance per minute.
Clinical relevance: Understanding match demands and positional differences in cerebral palsy soccer helps coaches plan tailored training sessions and drills to meet specific physical outputs. This knowledge supports training periodization, optimal player performance, and recovery. Insights into physical challenges for each position assist in scouting and adjusting training intensity.
PMID: 40444803

23.Developing an Inclusive Dance Guide for Children With Cerebral Palsy: A Co-Design Process and Initial Feasibility Study

Eduardo Duarte Machado, Laura Miller, Joanna Nicholas, Joanne Cross, Rhyannon Orr, Michael H Cole

Health Expect . 2025 Jun;28(3):e70304. doi: 10.1111/hex.70304.

Background: Participation in community activities has shown positive outcomes for all children, yet those with cerebral palsy (CP) still experience varying levels of inclusion. This study aimed to address the challenges faced by families of children with CP in accessing community-based dance classes by co-designing a practical guide to support their inclusion.
Design: The guide was developed through a collaborative process involving academic researchers, dance professionals, therapists and families of children with CP. The co-design phase was guided by the International Association for Public Participation (IAP2), workshops were conducted with 11 research partners, including two parents of children with CP, two community dance teachers, two therapists with experience in dance interventions and five academic researchers. Feedback from 'Dance Teacher Reviewers' who were not involved in the co-design was also incorporated to support the guide's initial feasibility.
Results: The collaborative efforts resulted in an evidence-based guide shaped by lived experiences. It provides actionable strategies to implement inclusive dance approaches effectively, supporting the inclusion of children with CP in community dance settings.
Conclusion: The co-designed guide represents a significant step toward facilitating inclusive dance classes for children with CP. Future research should explore the guide's effectiveness and feasibility of implementation across various community settings to ensure its broader applicability and impact.
Patient or public contribution: Parents of children with CP, dance teachers and therapists actively contributed to all stages of this study, from public consultation to collaborative co-design workshops, decision-making, review and refinement of the guide.
PMID: 40432276

24.An Aquatic Treadmill Alters Lower Limb Walking Dynamics in Typically Developing Children and Children with Cerebral Palsy

Oluwaseye Odanye, Joseph Harrington, Aaron Likens, David Kingston, Brian Knarr

Randomized Controlled Trial Sensors (Basel) . 2025 May 20;25(10):3220. doi: 10.3390/s25103220.

Abstract
This block-randomized crossover study investigated how a speed-modulated aquatic treadmill (AT) impacts the walking biomechanics of pediatric gait. Eight cerebral palsy (CP) and fifteen typically developing (TD) children walked at normal, slow, and fast treadmill speeds in AT and dry treadmill (DT) conditions. The joint angles of participants were calculated from inertial measurement units to derive sample entropy (SE) measures that quantified the regularity or complexity of motion. A hierarchical statistical model revealed that the CP group had lower SE values for the hip, knee, and ankle joints in the AT and at slower than faster treadmill speeds. Only the SE values of the knee and ankle joints were impacted for the TD group. The lower SE values suggest improved regularity for participants at slower speeds and in the AT environment. This study highlights the potential of AT to improve the walking biomechanics of children with CP in acute exposure, but further work is needed to investigate the AT condition as a gait rehabilitation environment.
PMID: 40432011

25.Effectiveness of Combined Whole-Body Vibration and Intensive Therapeutic Exercise on Functional Capacity in Children with Cerebral Palsy: A Randomized Controlled Trial

Iñigo Monzón-Tobalina, Rosa María Ortiz-Gutiérrez, Ángela Concepción Álvarez-Melcón, Álvaro Pérez-Somarriba, Patricia Martín-Casas, María José Díaz-Arribas

Randomized Controlled Trial Medicina (Kaunas) . 2025 May 9;61(5):873. doi: 10.3390/medicina61050873.

Abstract
Background and Objectives: Whole-body vibration (WBV) therapy presents controversial evidence regarding its effectiveness in improving lower limb functional capacity in children with cerebral palsy (CP), particularly when applied continuously as an adjunct to a physiotherapy program with demonstrated efficacy. This study aimed to evaluate the effectiveness of adding WBV to an intensive therapeutic exercise and functional training program in improving lower limb functional capacity in children with spastic CP. Materials and Methods: Thirty children with spastic CP were randomly assigned to a control or experimental group. Both groups completed a 4-week intensive therapeutic exercise and functional training program (4 sessions/week). The experimental group additionally received daily WBV. Results: Both groups showed significant improvements in all analysed variables at 1, 2, and 6 months post-treatment ($p < 0.001$). However, no significant between-group differences were found for primary (GMFM-88 D: $p = 0.80$; GMFM-88 E: $p = 0.91$) or secondary outcomes in relation to muscle tone and strength, and balance. A trend toward greater improvement was observed in the experimental group but without statistical significance. Conclusions: The addition of WBV to an intensive program of therapeutic exercise and functional training does not yield additional benefits in motor function, spasticity, gait capacity, lower limb muscle strength, or balance compared to intensive physiotherapy and functional training alone in children with spastic CP. The significant within-group improvements can be attributed to the intensive physiotherapy intervention, comprising therapeutic exercises and functional training.
PMID: 40428831

26.Active Start Active Future: Feasibility of a Behaviour-Change Intervention to Reduce Sedentary Behaviour and Promote Physical Activity in Young Children with Cerebral Palsy

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Phys Occup Ther Pediatr . 2025 May 26:1-24. doi: 10.1080/01942638.2025.2506061. Online ahead of print.

Aims: Children with cerebral palsy (CP) have low physical activity (PA) and high sedentary behavior. The aim was to trial a participation-focused behavior-change intervention to increase PA and decrease sedentary behavior.
Methods: Twelve children with CP were recruited (mean age 5 years 6 months ± 1 year 2 months, Gross Motor Function Classification System [GMFCS] levels I = 1, II = 1, III = 1, IV = 4, V = 5); eight with complete post-intervention data (mean 5 years 10 months ± 1 year 4 months, GMFCS I = 1, III = 1, IV = 4, V = 2). Children received 8 weekly sessions targeting individualized PA participation goals in a pre-post feasibility trial. Outcomes included: implementation, effectiveness (Canadian Occupational Performance Measure [COPM]), device-measured PA, goal confidence, quality of life, and barriers to PA participation. Semi-structured interviews explored acceptability and were analyzed thematically.
Results: Implementation was feasible with ≥90% sessions attended and high enjoyment (89.5%). After 8 wk, COPM goal performance (mean difference [MD] = 2.9, 95% CI 0.7, 5.0; $p = 0.02$), satisfaction with performance (MD = 3.0, 95% CI 1.6, 4.4; $p = 0.002$), and confidence (MD = 1.4, 95% CI 0.4, 2.5; $p = 0.02$) significantly increased with no change in other outcomes. All six caregivers interviewed reported the intervention to be acceptable.
Conclusions: Active Start Active Future was feasible to conduct, acceptable and showed preliminary evidence to improve PA in young children with CP.
PMID: 40415733

27.Automated Implementation of the Edinburgh Visual Gait Score (EVGS)

Ishaasamyuktha Somasundaram, Albert Tu, Ramiro Olleac, Natalie Baddour, Edward D Lemaire

Sensors (Basel) . 2025 May 21;25(10):3226. doi: 10.3390/s25103226.

Abstract
The Edinburgh Visual Gait Score (EVGS) is a commonly used clinical scale for assessing gait abnormalities, providing insight into diagnosis and treatment planning. However, its manual implementation is resource-intensive and requires time, expertise, and a controlled environment for video recording and analysis. To address these issues, an automated approach for scoring the EVGS was developed. Unlike past methods dependent on controlled environments or simulated videos, the proposed approach integrates pose estimation with new algorithms to handle operational challenges present in the dataset, such as minor camera movement during sagittal recordings, slight zoom variations in coronal views, and partial visibility (e.g., missing head) in some videos. The system uses OpenPose for pose estimation and new algorithms for automatic gait event detection, stride segmentation, and computation of the 17 EVGS parameters across the sagittal and coronal planes. Evaluation of gait videos of patients with cerebral palsy showed high accuracy for parameters such as hip and knee flexion but a need for improvement in pelvic rotation and hindfoot alignment scoring. This automated EVGS approach can minimize the workload for clinicians through the introduction of automated, rapid gait analysis and enable mobile-based applications for clinical decision-making.
PMID: 40432018

28.Development of a novel clinical outcome assessment: digital instrumental activities of daily living

Abbey Sawyer, Jamie Brannigan, Lisa Spielman; BCI Functional Outcome Measures Group; David Putrino, Adam Fry

EBioMedicine . 2025 May 26:116:105732. doi: 10.1016/j.ebiom.2025.105732. Online ahead of print.

Background: Digital technology is integral to activities of daily living, particularly instrumental activities of daily living (IADLs). However, tools that accommodate digital performance of IADLs are lacking. The aim of this study was to develop a novel Digital IADL Scale.
Methods: The multi-stage methodology included: (i) deductive item generation via a systematic review and assignment to domains using a Delphi process, (ii) inductive item generation via a survey of individuals with lived experience (IWLE) of severe paralysis, (iii) item refinement via item rating surveys of content experts and IWLE, and (iv) focus group discussions with key opinion leaders.
Findings: The systematic review identified 1250 IADL items from validated IADL measures, of which 353 met criteria. Deduplication reduced the deductive item set to 77, of which 42 remained following the Delphi process. IWLE generated 152 items, of which 132 met criteria. Deduplication reduced the inductive item set to 41. The combined item pool was reduced to 69 following the item rating surveys. Following focus group feedback, a list of nine domains, containing 37 items, and suggested response scale options are presented.
Interpretation: We describe the initial development of a scale to assess functional independence within IADLs that may be completed digitally, which will be submitted to further validation.
PMID: 40424668

29.Cognitive development at late infancy and school age in children cooled for neonatal encephalopathy

Sara Rapuc, Sally Jary, Ross E Vanderwert, David Odd, Ela Chakkarapani

Pediatr Res . 2025 May 30. doi: 10.1038/s41390-025-04152-4. Online ahead of print.

Background: We investigated the association and individual changes in cognitive scores between late infancy and early school age in children cooled for neonatal encephalopathy secondary to perinatal asphyxia (NE) who did not develop cerebral palsy.
Methods: We included 50 children born ≥35 weeks gestation cooled for NE who did not develop cerebral palsy. We assessed cognition using an average of cognitive and language composite scores (CLC) from Bayley Scales of Infant and Toddler Development (Bayley-III) at 18-21 months and full-scale IQ (FSIQ) on Wechsler Intelligence Scale for Children (WISC-IV) at 6-8 years. Linear regression was used to assess the association between CLC and FSIQ.
Results: Our cohort's mean gestation was 39.8 (SD 1.6) weeks; 59% male. 80% had moderate NE. CLC scores were significantly associated with FSIQ (Coef 0.45 (95% CI: 0.17, 0.72), R2 19%). About 45% of children's cognitive scores lowered from 18 to 21 months to 6-8 years of age, with two FSIQ clusters differing by deprivation (7.3 vs 5.5, p = 0.009). Increasing CLC threshold to 95 still did not identify 63% having an FSIQ < 85.
Conclusion: Bayley-III underestimates the delay at school age in children cooled for NE. Childhood IQ after NE appeared to be patterned by local deprivation.
Impact: Bayley-III underestimates school-age delays in children cooled for neonatal encephalopathy secondary to perinatal asphyxia (NE). Around 45% of children's cognitive scores moved to a lower developmental range at school age. Increasing the Bayley-III threshold to 95 failed to identify nearly two-thirds of children with IQ < 85. Childhood IQ after NE appeared to be patterned by local deprivation. Longitudinal monitoring of children cooled for neonatal encephalopathy secondary to perinatal asphyxia is needed to support their cognitive development.
PMID: 40447823

30.Informal Support Needs of Family Caregivers of Adults With Intellectual and Developmental Disabilities in India

Sumithra Murthy, Sarah Parker Harris, Kelly Hsieh

Intellect Dev Disabil . 2025 Jun 1;63(3):200-215. doi: 10.1352/1934-9556-63.3.200.

Abstract
Informal supports reduce stress and improve well-being for family caregivers of adults with intellectual and developmental (IDD) disabilities. A strengths-based mixed methods needs assessment was conducted with a convenience sample of 100 family caregivers in India to explore their informal needs and strategies for obtaining informal supports. Results showed that fewer caregivers received informal supports, and unemployed caregivers reported higher support needs for social interaction. Caregivers of adults who also had cerebral palsy were less likely to need opportunities to meet and talk with other caregivers. Caregivers believed that having more caregiver associations would result in better care provision for themselves and their family members with IDD. Seeking supports outside government/other formal systems seems like a promising family support strategy for caregivers in India.
PMID: 40425183

31.Rate differences in referrals and diagnostic outcomes of neurodevelopmental disorders between children with native and migrant backgrounds: a retrospective cohort study

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Eur Child Adolesc Psychiatry. 2025 May 27. doi: 10.1007/s00787-025-02744-3. Online ahead of print.

Abstract
Children of migrants have been reported to have increased likelihood of various neurodevelopmental disorders (NDDs), but little is known about differences in referral patterns for diagnostic assessment. This retrospective cohort study aimed to examine differences in referral rates and subsequent diagnostic outcomes between children with native (Icelandic parents) and migrant (at least one parent foreign-born) backgrounds in Iceland in five referral-year cohorts (2014-2018) using a nationwide database. Among 1,367 new referrals, children with migrant backgrounds (31.6%) were consistently referred at a significantly higher rate for assessment due to suspected autism spectrum disorder (ASD), intellectual disability (ID), or motor disorders such as cerebral palsy (CP), particularly children who were under 6 years old, male and second-generation immigrants (born in Iceland to two foreign-born parents). At follow-up, diagnostic outcomes most consistently differed for speech and language disorders (SLD), with significantly higher rates among children with migrant backgrounds across all cohorts. They also had significantly elevated rates of ASD diagnosis in three of the five cohorts, but no difference was found when co-occurring ID and SLD were excluded. Rates of ID (significantly elevated in one cohort) and CP (no difference in any cohort) were similar to those of children with native backgrounds. While it is positive that children with NDDs are not being overlooked due to their migrant backgrounds, the elevated rates of suspected NDDs in this population suggests a need for improved primary-level support with the aim of enhancing their well-being while reducing the demand for specialized diagnostic assessment and long-term support.
PMID: 40423709

32.Investigating the association between maternal age and cerebral palsy incidence: A meta-analysis

Jae Meen Lee, Kyoungjune Pak

Meta-Analysis Medicine (Baltimore) . 2025 May 23;104(21):e42568. doi: 10.1097/MD.0000000000042568.

Background: Cerebral palsy (CP) is a group of nonprogressive motor and postural disorders resulting from early developmental brain injury. While maternal age is a known factor associated with CP risk, previous studies have shown inconsistent findings, particularly regarding advanced maternal age. In addition, earlier meta-analyses often lack stratification by gestational age or do not include recent population-based studies. This meta-analysis aims to provide an updated and more detailed assessment of the association between maternal age at delivery and the risk of CP, using refined age group classifications and subgroup analyses based on gestational age.
Methods: We systematically searched the Embase, PubMed & Medline databases (from inception to March 2024) for English publications; we searched for all published studies comparing the number of cases (CP) and the number of controls according to maternal age. A meta-analysis was performed using R Statistical Software version 4.2.2 (The R Foundation for Statistical Computing). The odds of CP were examined among the maternal ages at delivery of 18 years old or younger, 25 years old or younger, 35 years old or older, or 40 years old or older, with a positive log odds ratio (OR) indicating higher odds of CP.
Results: From 9237 initially identified articles, 12 studies were ultimately included. Young maternal age (≤18 years old) was found to significantly increase the risk of CP (OR = 0.1374, P < .0001). The maternal groups defined by the ages of 25 and 35 years showed mixed risks, with term infants from mothers aged 35 years and older having higher odds of CP (OR = 0.9198, P = .0023).
Conclusions: CP risk is higher in children born to mothers aged 18 years or younger and may also increase in full-term births to mothers aged 35 years or older. These findings may help guide risk assessment and public health planning.
PMID: 40419867

33.Severity of punctate white matter lesions in preterm infants: antecedents and cerebral palsy prediction

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Pediatr Res . 2025 May 30. doi: 10.1038/s41390-025-04157-z. Online ahead of print.

Background: The objectives were to investigate antecedent factors of punctate white matter lesions (PWML) severity on MRI at term-corrected age (CA) and to evaluate its ability to independently predict cerebral palsy (CP) in preterm infants.
Methods: We studied infants born at ≤32 weeks' gestational age [GA] with brain MRI at term CA, a standardized neuromotor exam to determine CP diagnosis, and composite scores from Bayley Scales of Infant and Toddler Development-III(BSID-III) at 2 years CA. MRIs with PWML were manually segmented and volume quantified with high reliability. We correlated >50 perinatal antecedent factors with PWML severity and conducted multivariable regression analyses to assess PWML ability to independently predict neurodevelopmental outcomes at age 2.
Results: Of 392 infants, 28 (7.1%) had PWML; 339 (86%) were assessed at age 2, 39 (11.6%) had CP. Moderate-severe acute histologic chorioamnionitis (HCA), prenatal opioid use, and antenatal corticosteroids were independently associated with PWML severity. Increasing PWML severity was significantly predictive of CP (OR 2.12; 95% CI:1.34,3.37), independent of known predictors, but not BSID-III scores.
Conclusions: Increasing burden of PWML was associated with two-fold risk of CP in preterm infants. We also identified HCA, prenatal opioids, and antenatal corticosteroids as modifiable risk and protective factors for PWML that may be amenable to prevention efforts.
Impact: Punctate white matter lesions (PWML) are commonly seen on MRI scans in preterm infants, yet the antecedent factors associated with PWML are not well characterized. While prior literature is conflicting on the ability of PWML to predict neurodevelopmental impairments, our study demonstrated that objectively quantified PWML are independently predictive of the development of cerebral palsy. We identified modifiable factors such as histologic chorioamnionitis as a risk factor and antenatal corticosteroids as a protective factor against PWML development. Our findings may facilitate earlier identification of infants at risk for PWML and cerebral palsy.
PMID: 40447822

34.Bidirectional Projection-Based Multi-Modal Fusion Transformer for Early Detection of Cerebral Palsy in Infants

Kai Qi, Tingting Huang, Chao Jin, Yizhe Yang, Shihui Ying, Jian Sun, Jian Yang

IEEE Trans Med Imaging . 2025 May 30:PP. doi: 10.1109/TMI.2025.3575084. Online ahead of print.

Abstract
Periventricular white matter injury (PWMI) is the most frequent magnetic resonance imaging (MRI) finding in infants with Cerebral Palsy (CP). We aim to detect CP and identify subtle, sparse PWMI lesions in infants under two years of age with immature brain structures. Based on the characteristic that the responsible lesions are located within five target regions, we first construct a multi-modal dataset including 243 cases with the mask annotations of five target regions for delineating anatomical structures on T1-Weighted Imaging (T1WI) images, masks for lesions on T2-Weighted Imaging (T2WI) images, and categories (CP or Non-CP). Furthermore, we develop a bidirectional projection-based multi-modal fusion transformer (BiP-MFT), incorporating a Bidirectional Projection Fusion Module (BPFM) for integrating the features between five target regions on T1WI images and lesions on T2WI images. Our BiP-MFT achieves subject-level classification accuracy of 0.90, specificity of 0.87, and sensitivity of 0.94. It surpasses the best results of nine comparative methods, with 0.10, 0.08, and 0.09 improvements in classification accuracy, specificity and sensitivity respectively. Our BPFM outperforms eight compared feature fusion strategies using Transformer and U-Net backbones on our dataset. Ablation studies on the dataset annotations and model components justify the effectiveness of our annotation method and the model rationality. The proposed dataset and codes are available at https://github.com/Kai-Qi/BiP-MFT.
PMID: 40445813

35.'Feeling like you can't do anything because you don't know where to start'-Parents' Perspectives of Barriers and Facilitators to Accessing Early Detection for Children at Risk of Cerebral Palsy

Sue-Anne Davidson, Ashleigh Thornton, Deborah Hersh, Courtenay Harris, Catherine Elliott, Jane Valentine

Child Care Health Dev . 2025 Jul;51(4):e70100. doi: 10.1111/cch.70100.

Background: Early detection of cerebral palsy (CP) risk is possible from 12 weeks corrected gestational age (CGA) using standardised assessments; however, up to half of children at risk are not referred early, missing out on early intervention. We investigated the barriers and facilitators to accessing early intervention from the perspective of parents of children who did not receive services by 6 months CGA.
Methods: Parents of children with CP were invited to participate in qualitative semi structured interviews. Reflexive thematic analysis was used to analyse the data and develop themes.
Results: Eight mothers of children who did not receive standardised screening participated in interviews, from which three themes, 'responding to delays', 'systemic barriers' and 'complexities of diagnosis', were developed from the data.
Conclusions: Parents require more support to access and engage in early detection services; health system processes are difficult to navigate, and health professionals require education and training to recognise risk factors for CP in all health settings and refer promptly. Improving system processes, education and training and partnering early with parents to improve their experience when interacting with the health system may increase early engagement and optimise long-term outcomes for children at risk of CP and their families.
PMID: 40435382

36.Socioeconomic Disadvantage, Residential Remoteness and Access to Specialised Interventions in Cerebral Palsy: A Cross-Sectional Study

Simon P Paget, Kirsty Stewart, Lisa Copeland, Emma Waight, Nadine Smith, Felicity Baker, Jennifer Lewis, On Behalf Of The Australian Selective Dorsal Rhizotomy Research Group And Australian Paediatric Intrathecal Baclo-Fen Research Group

J Clin Med . 2025 May 20;14(10):3579. doi: 10.3390/jcm14103579.

Abstract
Aim: Socioeconomic factors are known to influence access to health services, including for children with cerebral palsy (CP). This study aims to determine whether socioeconomic disadvantage and/or geographical remoteness influence access to specialised CP interventions: selective dorsal rhizotomy (SDR) and intrathecal baclofen (ITB). Methods: This was a cross-sectional study of children with CP from (i) the Australian SDR Research Registry and (ii) an Australian ITB audit study. Socioeconomic disadvantage was grouped (quintiles) using the Index of Relative Socioeconomic Disadvantage (IRSD). Geographical remoteness was determined using the Australian Statistical Geographical Standard. IRSD quintiles and remoteness were compared with the Australian CP Register (ACPR) (birth years 1995-2016). Results: A total of 64 children (31.3% female) had received SDR surgery and 52 children (48.1% female) had received ITB therapy. Of these, 7 (11.1%) (SDR) and 7 (13.5%) (ITB) lived in the most disadvantaged neighbourhoods (IRSD quintile 1); 41 children (65.1%) (SDR) and 42 (82.4%) (ITB) lived in major cities. In comparison, 1630 (18.8%) of children on the ACPR resided in IRSD quintile 1; 6122 (70.4%) resided in major cities. There were no statistical differences in IRSD distribution between ACPR, SDR, and ITB groups. More children in major cities received ITB therapy ($p = 0.03$) and more children in outer regional/remote areas had received SDR ($p = 0.03$). Conclusions: Access to SDR and ITB in Australia varies by geographical remoteness. Equity of access is important to monitor, and interventions should be considered to reduce inequity.
PMID: 40429575

37.Clinical Evidence of Mesenchymal Stromal Cells for Cerebral Palsy: Scoping Review with Meta-Analysis of Efficacy in Gross Motor Outcomes

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Meta-Analysis Cells . 2025 May 12;14(10):700. doi: 10.3390/cells14100700.

Abstract
Mesenchymal stromal cells (MSCs) have been under clinical investigation for the treatment of cerebral palsy (CP) for over a decade. However, the field has been limited by study heterogeneity and variable reports of efficacy. We conducted a scoping review of published and registered reports of MSC treatment for CP, with meta-analysis of Gross Motor Function Measure (GMFM) outcomes to summarize research and provide future recommendations. Thirty published reports and 10 registered trials were identified, including 1292 people with CP receiving MSCs. Most received ≥2 doses (72%) of umbilical cord tissue MSCs (75%), intrathecally (40%) or intravenously (38%), and 31% were treated via compassionate/Expanded access. MSC treatment was safe and meta-analyses demonstrated that MSCs conferred significant improvements in GMFM at 3 - (1.05 (0.19 -1.92), p = 0.02), 6 - (0.97 (0.30-1.64), p = 0.005) and 12 months (0.99 (0.30-1.67), p = 0.005) post-treatment. Whilst MSCs are safe and improve GMFM outcomes in CP with large effect sizes, study and participant variability continues to confound data interpretation and limits subgroup analyses. With no published Phase 3 trials and high rates of compassionate access, the field would benefit from well-designed trials with unified outcomes. Additionally, data sharing to enable Individual Participant Data Meta-Analysis would support the determination of optimal source, route and dose to progress towards regulatory approval.
PMID: 40422203

Prevention and Cure

38.Prevalence and risk factors for neurodevelopmental impairment in very preterm infants without severe intraventricular hemorrhage or periventricular leukomalacia

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Early Hum Dev . 2025 Jul:206:106286. doi: 10.1016/j.earlhumdev.2025.106286. Epub 2025 May 17.

Objectives: To review the prevalence and risk factors for severe neurodevelopmental impairment (NDI) in infants born at 22-29 weeks of gestation without severe intraventricular hemorrhage (IVH) or periventricular leukomalacia (PVL).
Study design: This single-centered retrospective cohort study enrolled infants born at 22-29 weeks of gestation treated at Saitama Medical Center, Saitama Medical University, from 2005 to 2020. Patients with severe IVH or PVL were excluded. The primary outcome was severe NDI at 3 years of age, defined by the presence of neurodevelopmental delay (developmental quotient <70), severe cerebral palsy, or severe sensory deficit. The incidence of severe NDI was assessed, and its associated risk factors were analyzed using multivariable logistic regression.
Results: A total of 666 patients were analyzed, including 134 (20 %) who developed severe NDI. The prevalence of severe NDI was high among infants born at 22 weeks (19/26, 73 %) and 23 weeks (17/50, 34 %) of gestation. A multivariable logistic regression analysis with previously known predictors showed that lower birth weight, male sex, no antenatal corticosteroid therapy, and abdominal surgery were independently associated with severe NDI at 3 years of age.
Conclusions: As shown in previous studies, a high prevalence of severe NDI was observed in our cohort. Infants born at 22 and 23 weeks of gestation have a high risk of severe NDI even though they are without severe IVH or PVL. Antenatal corticosteroid therapy were beneficial for preventing severe NDI. Infants with a history of abdominal surgery require close monitoring for their neurodevelopmental outcomes.
PMID: 40412013