

Monday 29 August 2011

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Interventions and Management

1. Res Dev Disabil. 2011 Aug 19. [Epub ahead of print]

Three-dimensional upper limb movement characteristics in children with hemiplegic cerebral palsy and typically developing children.

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The aim of this study was to measure which three-dimensional spatiotemporal and kinematic parameters differentiate upper limb movement characteristics in children with hemiplegic cerebral palsy (HCP) from those in typically developing children (TDC), during various clinically relevant tasks. We used a standardized protocol containing three reach tasks (forwards, upwards, and sideways), two reach-to-grasp tasks (with objects requiring different hand orientations), and three gross motor tasks. Spatiotemporal (movement duration, trajectory straightness, maximum velocity, and timing of maximum velocity), as well as kinematic parameters (discrete angles and waveforms of the trunk, scapula, shoulder, elbow and wrist), were compared between 20 children with HCP (age 10.9 ± 2.9 years) and 20 individually age-matched TDC (age 10.9 ± 3.0 years). Kinematic calculations followed the recommendations from the International Society of Biomechanics. Results showed that children with HCP had longer movement durations, less straight hand trajectories, and lower maximum velocities compared to the TDC. Timing of maximum velocity did not differ between both groups. The movement pathology in children with HCP was highlighted by increased trunk movements and reduced shoulder elevation during reaching and reach-to-grasp. We also measured an increased anterior tilting and protraction of the scapula in children with HCP, although differences were not significant for all tasks. Finally, compared to the TDC, children with HCP used less elbow extension and supination and more wrist flexion to execute all tasks. This study reported distinct 3D upper limb movement characteristics in children with HCP and age-matched TDC, establishing the discriminative ability of the measurement procedure. From a clinical perspective, combining spatiotemporal and kinematic parameters may facilitate the identification of the pathological movement patterns seen in children with HCP and thereby add to a well-targeted upper limb treatment planning.

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PMID: 21862283 [PubMed - as supplied by publisher]

2. Eur J Paediatr Neurol. 2011 Aug 19. [Epub ahead of print]**Botulinum toxin treatment in upper limb spasticity: Treatment consistency.**

Papavasiliou AS, Nikaina I, Bouros P, Rizou I, Filiopoulos C.

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This study assessed treatment consistency of botulinum toxin administration in spastic upper limbs under pragmatic conditions, as derived through stability of dosages and between injections intervals. Over a period of 8 years, 153 children (81 with bilateral spastic cerebral palsy, 72 with unilateral) were treated according to accepted, experience-based guidelines with Botox and Dysport. Treatment response was based on assessment of spasticity and attainment of pre-determined goals at 3, 6 and 12 months post each treatment. Mean age at treatment onset was 6y 4mo (SD: 4y 10mo), median F/U, 2.5 years (4 months-6 8/12 years). Number of injection sessions was 1-10; few had more than 6 sessions. In 106 (69.28%) children, more than one anatomic regions of the limb were injected. Most (56.2%), had at least two injection sessions; median time interval between the sessions was 9 months (IQR: 4-35 months, similar for unilateral and bilateral cerebral palsy, $p = 0.874$). Children >4 years old at the first treatment had longer intervals between sessions (25.8%) compared to younger ones ($p = 0.010$). The mixed effects models demonstrated that botulinum toxin dosage was stable over subsequent visits ($p = 0.144$) and that intermediate intervals for subsequent visits were similar to the first one ($p = 0.279$).

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PMID: 21862370 [PubMed - as supplied by publisher]

3. J Neuroeng Rehabil. 2011 Aug 26;8(1):49. [Epub ahead of print]**Brain Computer Interface Controlled Functional Electrical Stimulation System for Ankle Movement.**

Do AH, Wang PT, King CE, Abiri A, Nenadic Z.

BACKGROUND: Many neurological conditions, such as stroke, spinal cord injury, and traumatic brain injury, can cause chronic gait function impairment due to foot-drop. Current physiotherapy techniques provide only a limited degree of motor function recovery in these individuals, and therefore novel therapies are needed. Brain-computer interface (BCI) is a relatively novel technology with a potential to restore, substitute, or augment lost motor behaviors in patients with neurological injuries. Here, we describe the first successful integration of a noninvasive electroencephalogram (EEG)-based BCI with a noninvasive functional electrical stimulation (FES) system that enables the direct brain control of foot dorsiflexion in able-bodied individuals. **METHODS:** A noninvasive EEG-based BCI system was integrated with a noninvasive FES system for foot dorsiflexion. Subjects underwent computer-cued epochs of repetitive foot dorsiflexion and idling while their EEG signals were recorded and stored for offline analysis. The analysis generated a prediction model, which allowed EEG data to be analyzed and classified in real time during online BCI operation. The real-time online performance of the integrated BCI-FES system was tested in a group of five able-bodied subjects, who used repetitive foot dorsiflexion to elicit BCI-FES mediated dorsiflexion of the contralateral foot. **RESULTS:** Five able-bodied subjects performed 10 alternations of idling and repetitive foot dorsiflexion to trigger BCI-FES mediated dorsiflexion of the contralateral foot. The epochs of BCI-FES mediated foot dorsiflexion were highly correlated with the epochs of voluntary foot dorsiflexion (correlation coefficient ranged between 0.59 and 0.77) with latencies ranging from 1.4 sec to 3.1 sec. In addition, all subjects achieved a 100% BCI-FES response (no omissions), and one subject had a single false alarm. **CONCLUSIONS:** This study suggests that the integration of a noninvasive BCI with a lower-extremity FES system is feasible. With additional modifications, the proposed BCI-FES system may offer a novel and effective therapy in the neuro-rehabilitation of individuals with lower extremity paralysis due to neurological injury.

PMID: 21867567 [PubMed - as supplied by publisher]

4. Ann Phys Rehabil Med. 2011 Aug 16. [Epub ahead of print]**Efficiency of flexible derotator in walking cerebral palsy children.**

Marcucci A, Edouard P, Loustalet E, d'Anjou MC, Gautheron V, Degache F.

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INTRODUCTION: The flexible derotator is one of the therapeutic resources used to combat primary and secondary abnormalities in walking cerebral palsy children. It was developed to reduce abnormal femoral and tibial torsions and lessen the latter's negative functional impact. **OBJECTIVE:** To determine the effect of wearing a flexible derotator on anatomic and functional parameters in walking cerebral palsy children. **METHODS:** We performed a retrospective study of walking cerebral palsy children by gathering data on bone-related parameters (femoral and tibial torsion) and functional parameters (distance and speed gait, and the energy expenditure index (EEI)). Fifteen walking cerebral palsy children were treated with the flexible derotator for one year and 15 untreated walking cerebral palsy children were included as controls. The two groups were compared in terms of the various parameters' change over time between the initial examination (the last examination prior to the start of the study or prior to use of the flexible derotator) and the final examination (after one year of follow-up). **RESULTS:** Right femoral anteversion and right and left external tibial torsion improved. There was a significant increase in distance and speed gait and a decrease in the EEI in walking cerebral palsy children. **CONCLUSION:** Our retrospective study revealed a significant improvement in functional parameters in children with cerebral palsy, as a result of wearing the flexible derotator for at least 6 hours a day for a year. Bone parameters only improved slightly. Use of the flexible derotator could improve these children's quality of life.

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PMID: 21868301 [PubMed - as supplied by publisher]

5. J Pediatr Orthop B. 2011 Aug 19. [Epub ahead of print]**Habitual anterior dislocation of the hip in cerebral palsy: a case report.**

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Habitual anterior dislocation of the hip joint is extremely rare. We believe this is the first case reported of a habitual anterior dislocation of the hip occurring in a child with cerebral palsy. The dislocation was painless, voluntary and used to occur every time the child would extend and externally rotate the limb. Operative intervention in the form of a varus derotation femoral osteotomy and anterior capsulorrhaphy was planned, but the caregivers of the patient were unwilling for the same. Hence, the patient was given an adduction and internal rotation brace and was counselled not to perform the activity needed to dislocate the hip. This case report calls attention to a unique problem previously not reported in cerebral palsy.

PMID: 21857541 [PubMed - as supplied by publisher]

6. Prosthet Orthot Int. 2011 Mar;35(1):45-53.**Weight transfer analysis in adults with hemiplegia using ankle foot orthosis.**

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BACKGROUND: Identifying and understanding the changes in transfer of momentum that are directly affected by orthotic intervention are significant factors related to the improvement of mobility in individuals with hemiplegia.

OBJECTIVES: The purpose of this investigation was to use a novel analysis technique to objectively measure weight transfer during double support (DS) in healthy individuals and individuals with hemiplegia secondary to stroke with and without an ankle foot orthosis. **STUDY DESIGN:** Prospective, Repeated measures, case-controlled trial. **METHODS:** Participants included 25 adults with stroke-related hemiplegia >6 months using a prescribed ankle foot orthosis and 12 age-matched healthy controls. Main outcome measures included the weight transfer point timing (WTP, %DS), maximum total force timing (MTF, %DS), timing difference between WTP and MTF (MTF-WTP, %DS) and the linearity of loading (LOL, R(2)) during the DS phase of the gait cycle. **RESULTS:** The WTP and LOL were significantly different between conditions with and without the ankle foot orthosis for the affected and unaffected limb in post-stroke individuals, $p \leq 0.01$. The MTF and difference in timing between MTF-WTP were significantly different during affected limb loading with and without the ankle foot orthosis in the stroke group, $p \leq 0.0001$ and $p = 0.03$, respectively. MTF, MTF-WTP and LOL were significantly different between individuals with stroke (during affected limb loading) and healthy controls (during right limb loading). **CONCLUSIONS:** This research established a systematic method for analysing weight transfer during walking to evaluate the effect of an ankle foot orthosis on loading during double support in hemiplegic gait. This novel method can be used to elucidate biomechanical mechanisms behind orthosis-mediated changes in gait patterns and quantify functional mobility outcomes in rehabilitation. **CLINICAL RELEVANCE:** This novel approach to orthotic assessment will provide the clinician with needed objective evidence to select the most effective orthotic intervention to maximize functional recovery for individuals with hemiplegia secondary to stroke.

PMID: 21515889 [PubMed - indexed for MEDLINE]

7. Chir Narzadow Ruchu Ortop Pol. 2011 Mar-Apr;76(2):91-5.

Effectiveness of botulinum toxin in diminishing lower limbs spasticity in children with diplegic form of cerebral palsy [Article in Polish]

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INTRODUCTION: Intramuscular injection of botulinum toxine (BTX-A) is important method of spasticity treatment in cerebral palsy (CP) children. **RESEARCH AND METHOD:** Research group consisted of 60 children, aged 2-8 with diagnosed diplegic form of CP treated in years 2002-2004 with BTX-A. Research was conducted before and approximately four weeks and three months after injections. Third examination was performed just before another injection. Patients on the functional level II to IV according to GMFCS were qualified for study. Level of spasticity, range of motion (ROM) and course of rehabilitation were assessed each time. Effectiveness of therapy was also studied based of parent's opinions. **RESEARCH OUTCOMES:** According to GMFCS 14 children (23.3%) were classified to level II, 29 children (48.4%) to level III and 17 (28.3%) to level IV. In all children spasticity decreased. ROM measured by fast and slow movement in hip, knee and ankle joints increased significantly. During treatment Reimers index was bilaterally normal in 38%, unilaterally in 11% of patients. Index value was normalized in 7.7% of patients. Therapeutic effect of applied treatment method was observed by 96.7% of parents. No side effects have been observed. **CONCLUSIONS:** By means of BTX-A injections temporary reduction of spasticity in selected muscle groups can be achieved. Injections of BTX-A to hip adductors influence Reimers index helping to prevent norm value. After subsequent injections of BTX-A time period of therapeutic effect changes. Parents of treated children assess BTX-A therapy as highly effective.

PMID: 21853909 [PubMed - in process]

8. Chir Narzadow Ruchu Ortop Pol. 2010 Sep-Oct;75(5):318-22.

Quality of life in cerebral palsy children treated with intrathecal baclofen pump implantation in parents' opinion [Article in Polish]

Borowski A, Pruszczyński B, Miller F, Synder M.

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INTRODUCTION: Most common disorder in patients with cerebral palsy (CP) is spasticity. It is a result of non-

progressing damage of Upper Motor Neuron system, causing imbalance signals, and consequently increasing muscle activity. Spasticity decreased activity of daily living of the patient and their caregivers. It may cause many medical and social problems. Baclofen is a synthetic analog of gamma-aminobutyric acid, administered in intrathecal space by pump. It inhibits both monosynaptic and polysynaptic spinal reflexes. First time baclofen pump (ITB) were applied by Penn and Kroin in 1984 to treat spasticity. ITB is indicated in severe children cerebral palsy, especially in tetraparesis. The purpose of this study is attempt for objective and subjective evaluation of the quality of life after implantation of ITB. MATERIAL AND METHODS: In this research data of 161 children were analyzed with spastic tetraparesis (GMFCS V). Evaluation was based on an analysis of the quantity of additional surgical procedures before and after ITB implantation. Subjective assessment was made using questionnaires addressed to parents on fundamental aspects of everyday activities and quality of life after implantation of ITB. RESULTS: The average age AT the time of surgery was 12 year and 2 months (SD 4.7). The average follow up was 3 years and 2 months (SD 2.4). During ITB implantation additional surgical procedure were performed in 43% of Children. During the next scheduled ITB pump exchange indication to additional surgical procedure was reduced to 20%. The average questionnaire score was 13 points (0-16 max.). Fifty eight percents of caregivers of children who had any kind of device related complication scored with average score 13.5. CONCLUSION: 1) ITB implantation in the treatment of children with severe CP improves their quality of life. 2) Indication to perform surgical procedures were reduced in patients treated with ITB. 3) ITB implantation correlates with the high level of caregivers satisfaction as the potential for improvements, however one have to think about the complication.

PMID: 21853903 [PubMed - in process]

9. Clin Orthop Relat Res. 2011 Aug 24. [Epub ahead of print]

Case Reports: The Influence of Selective Voluntary Motor Control on Gait After Hamstring Lengthening Surgery.

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BACKGROUND: Preliminary evidence suggests selective voluntary motor control (SVMC), defined as performance of isolated voluntary joint movement on request, may be an important factor affecting functional movement tasks. Individuals with poor SVMC are unable to dissociate hip and knee synergistic movement during the swing phase of gait and have difficulty extending their knee while the hip is flexing during terminal swing regardless of hamstring length. This pattern may limit their ability to take advantage of hamstring-lengthening surgery (HLS) and may explain a lack of improved stride length postoperatively. QUESTIONS/PURPOSES: Provide a preliminary clinical and conceptual framework for using SVMC to predict swing phase parameters of gait after HLS. PATIENTS AND METHODS: We contrasted two patients with spastic diplegia of similar age, gross motor function, and spasticity but with different SVMC scores using the Selective Control Assessment of the Lower Extremity (SCALE). The patients underwent bilateral HLS. Popliteal angles, joint kinematics, step length, stride length, and walking velocity were assessed pre- and postoperatively. RESULT: Popliteal angles, terminal knee extension, and knee range of motion improved for both patients. However, only the patient with higher SCALE scores improved stride length postoperatively. CONCLUSION: Although preliminary, the data suggest that SVMC, as measured by SCALE, may be a prognostic factor for improved stride length after HLS in patients with spastic diplegia.

LEVEL OF EVIDENCE: Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

PMID: 21863394 [PubMed - as supplied by publisher]

10. Res Dev Disabil. 2011 Aug 18. [Epub ahead of print]**Developmental milestones in toddlers with atypical development.**

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The attainment of developmental milestones was examined and compared in 162 infants and toddlers with developmental disabilities, including Down Syndrome (n=26), Cerebral Palsy (n=19), Global Developmental Delay (n=22), Premature birth (n=66), and Seizure Disorder (n=29). Toddlers in the Seizures Disorder group began crawling at a significantly younger age than toddlers in the Down Syndrome and Cerebral Palsy groups. Additionally, toddlers in the Seizure Disorder group began walking at a younger age than children in the Down Syndrome, Cerebral Palsy, and Global Developmental Delay groups, while toddlers in the Prematurity group began walking at a younger age than children in the Down Syndrome group. No between group differences were found with respect to age at which first words were spoken. Results and their implications are discussed.

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PMID: 21855292 [PubMed - as supplied by publisher]

11. Braz Oral Res. 2011 Aug;25(4):319-23.**Dental trauma in individuals with severe cerebral palsy: prevalence and associated factors.**

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The aim of the present study was to determine the prevalence of dental trauma and associated factors among a sample of patients with severe cerebral palsy. The sample was made up of 120 individuals equally divided into two groups. The group with cerebral palsy was made up of 60 patients diagnosed with the spastic form of the disease. The control group was made up of 60 individuals with no mental impairment. Questionnaires were used to collect information on individual, socioeconomic and behavioral characteristics. Dental trauma was assessed based on the clinical chart of each participant, on a questionnaire and on a clinical evaluation to determine past injuries. Mouth mirrors and millimeter periodontal probes (Community Periodontal Index probe) were used to measure overjet. Lip seal and breathing type were determined during the clinical exams and interviews. Statistical analysis involved the chi-square test ($p < 0.05$) and multivariate logistic regression (forward stepwise procedure). The prevalence of dental trauma was greater among individuals with cerebral palsy (18%) than in the control group (5%), with the difference achieving statistical significance ($p = 0.023$). Individuals with lip incompetence had a greater chance of exhibiting dental trauma (OR [CI 95%] = 3.81 [1.19-12.24]). The prevalence of dental trauma among individuals with cerebral palsy was high. A lack of lip seal was identified as a factor directly associated to this prevalence.

PMID: 21860919 [PubMed - in process]

Prevention and Cure

12. *Obstet Gynecol.* 2011 Sep;118(3):576-582.

Epidemiologic Associations With Cerebral Palsy.

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OBJECTIVE: To estimate epidemiologic risk factors for cerebral palsy. **METHODS:** Data were collected by linkage to state-based perinatal repositories and cerebral palsy registers and using a maternal questionnaire. The cohort included 587 individuals with cerebral palsy and 1,154 non-cerebral palsy controls. **RESULTS:** The following factors were associated with cerebral palsy: recorded maternal infection during pregnancy (41.4% patients compared with 31.3% controls; odds ratio [OR] 1.55, 95% confidence interval 1.26-1.91), small for gestational age ([birth weight less than third customized centile] 43.9% patients compared with 6.3% controls; OR 11.75, 6.25-22.08), gestational age less than 32 weeks (29.3% patients compared with 0.7% controls; OR 59.20, 28.87-121.38), multiple birth (OR 6.62, 4.00-10.95), a relative with cerebral palsy (OR 1.61, 1.12-2.32), breech position (13.7% patients compared with 6.0% controls; OR 2.48, 1.76-3.49), bleeding at any time in pregnancy (29.3% patients compared with 16.9% controls; OR 2.04, 1.61-2.58), male sex (58.8% patients compared with 45.8% controls; OR 1.68, 1.38-2.06), multiple miscarriage (7.7% patients compared with 3.5% controls; OR 2.30, 1.38-3.82), smoking (14.0% patients compared with 10.6% controls; OR 1.37, 1.02-1.85), and illicit drug use (3.3% patients compared with 1.5% controls; OR 2.22, 1.14-4.30). Factors not associated with cerebral palsy were "disappearing twin," diabetes, maternal body mass index, hypertension, alcohol consumption, anemia, maternal hypothyroidism, forceps or vacuum delivery, and maternal age. **CONCLUSION:** Preterm birth, intrauterine growth restriction, perinatal infection, and multiple birth present the largest risks for a cerebral palsy outcome. Reassuringly, upper respiratory tract and gastrointestinal infections during pregnancy were not associated with cerebral palsy.

LEVEL OF EVIDENCE: II.

PMID: 21860286 [PubMed - as supplied by publisher]

13. *Pediatr Res.* 2011 Aug 18. [Epub ahead of print]

Candidate Genes and Risk for Cerebral Palsy: a Population-Based Study.

Wu YW, Croen LA, Vanderwerf A, Gelfand AA, Torres AR.

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Studies suggest genetic polymorphisms may increase an individual's susceptibility to CP. Most findings have yet to be corroborated in an independent cohort. This case-control study is nested within all 334,333 infants \geq 36 weeks gestation born at Kaiser Permanente Medical Care Program, 1991-2002. We included only non-Hispanic whites who had a neonatal blood sample available. Case patients (N=138) were identified from medical records to have spastic or dyskinetic CP. Controls (N=165) were randomly selected from the population. We genotyped polymorphisms previously associated with CP: inducible nitric oxide synthase (iNOS) -231, apolipoprotein E (apoE) ϵ 2 and ϵ 4 alleles, tumor necrosis factor- α -308, interleukin-8 -251, lymphotoxin 60, endothelial nitric oxide synthase -922, endothelial protein C receptor 219, mannose binding lectin 54 and 52, factor V Leiden, methyltetrahydrofolate reductase 1298 and 667, prothrombin 20210, and platelet activator inhibitor 11053. Similar

to previous reports, the iNOS -231 T allele (25.7% vs. 18.9%, $P=0.04$) and the apoE ϵ 4 allele (19.3% vs. 13.2%, $P=0.04$) were more common in patients with CP than in controls. However, there was no statistically significant association between any genetic polymorphism and CP after correction for multiple comparisons.

PMID: 21857382 [PubMed - as supplied by publisher]

14. Am J Obstet Gynecol. 2011 Jul 20. [Epub ahead of print]

A systematic review of severe morbidity in infants born late preterm.

Teune MJ, Bakhuizen S, Bannerman CG, Opmeer BC, van Kaam AH, van Wassenaeer AG, Morris JM, Mol BW.

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OBJECTIVE: Late-preterm infants (34 weeks 0/7 days-36 weeks 6/7 days' gestation) represent the largest proportion of singleton preterm births. A systematic review was performed to assess the short- and/or long-term morbidity of late-preterm infants. **STUDY DESIGN:** An electronic search was conducted for cohort studies published from January 2000 through July 2010. **RESULTS:** We identified 22 studies studying 29,375,675 infants. Compared with infants born at term, infants born late preterm were more likely to suffer poorer short-term outcomes such as respiratory distress syndrome (relative risk [RR], 17.3), intraventricular hemorrhage (RR, 4.9), and death <28 days (RR, 5.9). Beyond the neonatal period, late-preterm infants were more likely to die in the first year (RR, 3.7) and to suffer from cerebral palsy (RR, 3.1). **CONCLUSION:** Although the absolute incidence of neonatal mortality and morbidity in infants born late preterm is low, its incidence is significantly increased as compared with infants born at term.

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PMID: 21864824 [PubMed - as supplied by publisher]

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