Category: Assessment

Title: Evolution of foot and ankle manifestations in children with CMT1A

Abstract: We studied the timing and progression of foot and ankle changes in 81 children with genetically confirmed Charcot-Marie-Tooth disease type 1A (CMT1A) and determined their impact on motor function and walking ability. Foot deformity, weakness, pain, cramps, and instability were a common feature of CMT1A. Foot structure evolved toward pes cavus from early childhood to adolescence, although a subgroup with normal and planus feet remained. Foot strength increased with age, although compared to age-equivalent norms it declined from 4 years. Factors associated with evolving foot deformity included muscle weakness/imbalance, restricted ankle flexibility, and joint hypermobility. Regression modeling identified dorsiflexion weakness, global foot weakness, and difficulty toe-walking as independent predictors of motor dysfunction, while pes cavus and difficulty heel-walking were predictors of poor walking ability. Foot problems are present from the earliest stages of the disease and can have a negative impact on function. Early foot and ankle intervention may prevent long-term disability and morbidity in CMT1A.

Authors' Notes: Identification and management of early foot and ankle involvement may prevent long-term disability and impairment in people with Charcot-Marie-Tooth disease.

Reference: Burns J. Ryan MM. Ouvrier RA. Evolution of foot and ankle manifestations in children with CMT1A. *Muscle & Nerve 39(2) 158-66, 2009.*

To read the full version of this paper or to ask a question about the study, please email the author Dr. Josh Burns: joshuab2@chw.edu.au

Category: Assessment

Title: Quality of Life in Children with Charcot-Marie-Tooth Disease

Abstract: The authors studied the health-related quality of life of children aged 5 to 18 years with Charcot-Marie-Tooth disease of varying types and severity and compared it with the general pediatric population. To capture and compare the quality-of-life data across a broad range of ages, the Child Health Questionnaire was completed by parents of 127 children with Charcot-Marie-Tooth disease. Affected children exhibited lower physical, psychological, and social well-being than the general pediatric population, with subsequent worsening of many domains with age. The type of Charcot-Marie-Tooth disease influenced some physical and behavioral quality-of-life domains, while gender, body size, and ethnicity did not. Parent characteristics had generally little impact on the reporting of their child's quality of life, although parents with Charcot-Marie-Tooth disease reported higher bodily pain in their children than those without.

Authors' Notes: Treatment should target quality of life because it is negatively affected by the presence and severity of Charcot-Marie-Tooth disease in childhood.

References:

- Burns J. Ryan MM. Ouvrier RA. Quality of life in children with Charcot-Marie-Tooth disease. Journal of Child Neurology 2009, doi:10.1177/0883073809339877.
- Burns J. Quality of Life in children with CMT type 1A [Correspondence]. *Lancet Neurology* 8(10), 881, 2009.

To read the full version of this paper or to ask a question about the study, please email the author Dr. Josh Burns: joshuab2@chw.edu.au

Category: Assessment

Title: Factors Associated with Foot and Ankle Strength in Healthy Preschool-age Children and Age-matched Cases of Charcot-Marie-Tooth Disease Type 1A

Abstract: Charcot-Marie-Tooth disease affects foot and ankle strength from the earliest stages of the disease; however, little is known about factors influencing normal strength development or the pathogenesis of foot weakness and deformity in Charcot-Marie-Tooth disease. The authors investigated factors associated with foot and ankle strength in healthy preschool-age children and compared to age-matched cases of Charcot-Marie-Tooth disease type 1A. In healthy children, ankle dorsiflexion range of motion was one of the strongest independent correlates of foot and ankle strength. Compared with healthy children, those with Charcot-Marie-Tooth disease type 1A had significantly less dorsiflexion strength and range as well as imbalance in inversion-to-eversion and plantarflexion-to-dorsiflexion strength ratios. Given the association between ankle dorsiflexion strength and range in the healthy children, and the abnormality of these parameters in Charcot-Marie-Tooth disease, investigation of the cause-effect relationship is warranted to identify more targeted therapy and further understand the pathogenesis of foot deformity in Charcot-Marie-Tooth disease.

Authors' Notes: Limited ankle range of motion may be a contributing factor to the presence and severity of high-arched feet (pes cavus) in Charcot-Marie-Tooth disease.

Reference: Rose KJ. Burns J. North KN. Factors associated with foot and ankle strength in healthy preschool-age children and age-matched cases of Charcot-Marie-Tooth disease type 1A. *Journal of Child Neurology* 2009, doi:10.1177/0883073809340698.

To read the full version of this paper or to ask a question about the study, please email the author Dr. Josh Burns: joshuab2@chw.edu.au

Category: Assessment

Title: Hand Involvement in Children with Charcot-Marie-Tooth Disease Type 1A

Abstract: Charcot-Marie-Tooth disease type 1A (CMT1A), a demyelinating neuropathy characterised by progressive length-dependent muscle weakness and atrophy, is thought to affect the foot and leg first followed some time later by hand weakness and dysfunction. We aimed to characterise hand strength, function and disease-related symptoms in children with CMT1A. Intrinsic and extrinsic hand strength was measured by hand-held dynamometry, function by nine-hole peg test, and disease-related symptoms by interview and examination in 84 affected children aged 2-16 years. Hand weakness and dysfunction was present from the earliest stages of the disease. While hand strength and function measures tended to increase with age throughout childhood, at no point did they reach normal values. Day-to-day hand problems such as poor handwriting, weakness, pain and sensory symptoms also worsened with age. The hand is affected at all ages in children with CMT1A, but may be under-recognised in its early stages, potentially delaying therapy.

Authors' Notes: Children with CMT1A experience hand weakness and dysfunction from an early age. This weakness and functional difficulty is expected to impact negatively on day-to-day activities, and may be under-recognised. Further research is required to determine the extent to which early intervention may improve hand function and prevent long-term disability in CMT1A.

Reference: Burns J. Bray P. Cross L. North KN. Ryan MM. Ouvrier RA. Hand involvement in children with Charcot-Marie-Tooth disease type 1A. *Neuromuscular Disorders 18(12):970-973, 2008.*

To read the full version of this paper or to ask a question about the study, please email the author Dr. Josh Burns: joshuab2@chw.edu.au

Category: Assessment

Title: Factors That Influence Health-related Quality of Life in Australian Adults with Charcot-Marie-Tooth Disease.

Abstract: Health-related, quality of life (HRQoL) is an important outcome in clinical trials of patients with Charcot-Marie-Tooth disease (CMT). In a cross-sectional survey of 295 Australian adults with CMT, HRQoL was measured using the Short Form-36 (SF-36) and predictors of reduced HRQoL were identified with a CMT-specific health status questionnaire. People with CMT demonstrated lower HRQoL scores than the general Australian population in all SF-36 dimensions. The disparity between people with CMT and normative data was greater for physical dimensions than for mental health dimensions. SF-36 scores were generally lower in older vs younger people, but not between men and women, or between CMT types. HRQoL in CMT was predicted strongly by lower limb weakness and to a lesser extent by leg cramps, suggesting clinical trials targeting weakness and cramps may improve HRQoL in patients with CMT.

Authors' Notes: The addition of health-related quality of life outcome measures in clinical trials of therapies for patients with CMT are essential to obtain patients' views as to the effectiveness of a potential treatment. This is especially important in trials where the primary endpoint may be one that lacks obvious relevance to patients' day-to-day experiences such as nerve conduction studies, muscle strength scores or sensory testing.

Reference: Redmond AC. Burns J. Ouvrier RA. Factors that influence health-related quality of life in Australian adults with Charcot-Marie-Tooth disease. *Neuromuscular Disorders. 18(8):619-25, 2008.*

To read the full version of this paper or to ask a question about the study, please email the author Dr. Josh Burns: joshuab2@chw.edu.au

Category: Assessment

Title: Pressure Characteristics in Painful Pes Cavus Feet Resulting From Charcot-Marie-Tooth Disease

Abstract: Charcot-Marie-Tooth (CMT) disease often presents with peripheral muscle imbalance associated with a painful cavus (medial high-arched) foot deformity which becomes increasingly severe and rigid as the disease progresses. The purpose of this study was to investigate the effect of pes cavus on foot pain and dynamic plantar pressure in CMT, and to explore the relationships between plantar pressure and pain. Sixteen participants diagnosed with CMT and painful pes cavus were assessed for foot posture, ankle dorsiflexion range of motion, levels of foot pain, functional impairment, health-related quality of life and plantar pressure distribution while walking. Plantar pressure parameters (mean pressure, peak pressure, pressure-time integral) and contact duration were measured using the Novel Pedar in-shoe capacitance transducer system and the foot was divided into rearfoot, midfoot and forefoot regions for analysis. Increasing cavus foot deformity was associated with more widespread foot pain and increased pressure under the forefoot and midfoot regions. In contrast, peak pressure decreased under the rearfoot. Neither relationship was found between foot pain intensity and any of the pressure variables, nor was ankle dorsiflexion range of motion correlated with pain location, intensity or degree of pes cavus. Although pes cavus in CMT is associated with substantial pain and dysfunction, there is no clear link between foot pain and plantar pressure. The more severe the degree of pes cavus, however, the more pressure develops under the lateral margin of the foot; probably as a result of the changed foot-ground contact seen during gait.

Authors' Notes: There is a clear need to recognize the impact of the progressive high-arch foot deformity and the change in gait characteristics with respect to the changing foot pressures. In particular, protection of the lateral midfoot is an important strategy in the management of patients with CMT, especially as the condition progresses.

Reference: Crosbie J. Burns J. Ouvrier R. Pressure characteristics in painful pes cavus feet resulting from Charcot-Marie-Tooth disease. *Gait & Posture. 28(4):545-51, 2008.*

To read the full version of this paper or to ask a question about the study, please email the author Dr. Josh Burns: joshuab2@chw.edu.au

Category: Assessment

Title: Neurophysiologic Abnormalities in Children with Charcot-Marie-Tooth Disease Type 1A.

Abstract: Although Charcot-Marie-Tooth disease type 1A (CMT1A) initially manifests in the first decade, there are no large studies describing its neurophysiologic features in childhood. We report neurophysiologic findings in 80 children aged 2-16 years with CMT1A who underwent median motor and sensory nerve conduction studies. Neurophysiologic abnormalities were present in all children. Median motor nerve conduction velocity was invariably less than 33 m/s (mean 18.7 m/s, range 9.0-32.9 m/s), with conduction velocities significantly slower in children aged 7-16 years compared with children aged 6 years and below. All children had prolonged distal motor latencies (mean 7.3 ms, range 4.0-12.3 ms). The compound muscle action potential (CMAP) amplitude was reduced from an early age (mean 7.1 mV, range 2.1-13.5 mV), and its normal increase with age was attenuated. Median sensory responses were present in only seven children, all aged less than 9 years and with slowed sensory conduction. Neurophysiologic abnormalities are present in all children with CMT1A from the age of 2 years. Motor conduction slowing progresses through the first 6 years of life and thereafter remains stable. CMAP amplitude is reduced from an early age, and the normal physiologic increase with age is attenuated. Median sensory responses may be recorded in younger children, and their presence does not exclude the diagnosis of CMT1A.

Authors' Notes: Longitudinal studies of this large cohort of children with CMT1A will be of interest to understand the natural history of neurophysiology into adulthood.

Reference: Yiu E. Burns J. Ryan MM. Ouvrier RA. Neurophysiologic abnormalities in children with Charcot-Marie-Tooth disease type 1A. *Journal of the Peripheral Nervous System. 13(3):236-241, 2008.*

To read the full version of this paper or to ask a question about the study, please email the author Dr. Josh Burns: joshuab2@chw.edu.au

Category: Assessment

Title: The Effect of Pes Cavus on Foot Pain and Plantar Pressure

Abstract: BACKGROUND: Clinical management of patients with painful pes cavus is challenging because the mechanism of foot pain is poorly understood. The purpose of this study was to explore the influence of various pes cavus aetiologies on foot pain and plantar pressure characteristics, and to identify the relationship between foot pain and plantar pressure. METHODS: Seventy subjects were recruited for this study. They included 30 subjects with pes cavus of unknown aetiology (idiopathic), 10 subjects with pes cavus of neurological aetiology (neurogenic) and 30 subjects with a normal foot type. The presence and location of foot pain was recorded and barefoot plantar pressures were measured using the EMED-SF platform for the whole foot, rearfoot, midfoot and forefoot regions. FINDINGS: Subjects with pes cavus of either idiopathic or neurogenic aetiology reported a higher proportion of foot pain (60%) compared to subjects with a normal foot type (23%) (P=0.009). Pressure-time integrals under the whole foot, rearfoot and forefoot regions in pes cavus, of both idiopathic and neurogenic origin, were higher than in the normal foot type (P<0.01). Pressure-time integrals in subjects reporting foot pain were higher than for pain free subjects (P<0.001). There was a significant correlation between pressure-time integral and foot pain (r=0.49, P<0.001). INTERPRETATION: Foot pain is a common finding among individuals with pes cavus. Regardless of aetiology, pes cavus is characterized by abnormally high pressure-time integrals which are significantly related to foot pain. An understanding of the relationship between pes cavus pressure patterns and foot pain will improve the clinical management of these patients.

Authors' Notes: Foot pain is a common finding in people with high-arched feet (pes cavus). The results of this study show that pressure patterns differ between cavoid and normal feet. Regardless of the cause, high-arched feet are characterized by high pressure under the rearfoot and forefoot which are significantly related to foot pain.

Reference: Burns J. Crosbie J. Hunt A. Ouvrier R. The effect of pes cavus on foot pain and plantar pressure. *Clinical Biomechanics. 20(9):877-82, 2005.*

To read the full version of this paper or to ask a question about the study, please email the author Dr. Josh Burns: joshuab2@chw.edu.au

Category: Assessment

Title: Quantification of Muscle Strength and Imbalance in Neurogenic Pes Cavus, Compared to Health Controls, Using Hand-held Dynamometry

Abstract: BACKGROUND: Pes cavus foot deformity in neuromuscular disease is thought to be related to an imbalance of musculature around the foot and ankle. The most common cause of neurogenic pes cavus is Charcot-Marie-Tooth (CMT) disease. The aim of this investigation was to objectively quantify muscle strength and imbalance using hand-held dynamometry in patients diagnosed with CMT and pes cavus, compared to healthy controls. METHODS: Muscles responsible for inversion, eversion, plantarflexion, and dorsiflexion of the foot and ankle were measured in 55 subjects (11 CMT patients with a frank pes cavus, and 44 healthy controls with normal feet) using the Nicholas hand-held dynamometer (HHD). Test-retest reliability of the HHD procedure also was determined for each of the four muscle groups in the healthy controls. RESULTS: Test-retest reliability of the HHD procedure was excellent (ICC3,1 = 0.88 to 0.95) and the measurement error was low (SEM = 0.3 to 0.7 kg). Patients with CMT were significantly weaker than normal for all foot and ankle muscle groups tested ($p < 0.001$). Strength ratios of inversion-to-eversion and plantarflexion-to-dorsiflexion were significantly higher in the patients with CMT and pes cavus compared to individuals with normal foot types ($p > 0.01$). CONCLUSIONS: Hand-held dynamometry is an objective and reliable instrument to measure muscle strength and imbalance in patients with CMT and a pes cavus foot deformity.

Authors' Notes: Patients with CMT and a pes cavus foot deformity are substantially weaker than those without CMT and demonstrate considerable imbalance of foot and ankle strength.

References

- Burns J. Redmond A. Ouvrier R. Crosbie J. Quantification of muscle strength and imbalance in neurogenic pes cavus, compared to health controls, using hand-held dynamometry. *Foot & Ankle International. 26(7):540-4, 2005.*
- Rose KJ. Burns J. Ryan MM. Ouvrier RA. North KN. Reliability of quantifying foot and ankle muscle strength in very young children. *Muscle & Nerve. 37(5):626-31, 2008.*
- Burns J. Ouvrier R. Pes cavus pathogenesis in Charcot-Marie-Tooth disease type 1A. *Brain. 129(Pt 7):E50-51, 2006.*

To read the full version of this paper or to ask a question about the study, please email the author Dr. Josh Burns: joshuab2@chw.edu.au