SPECIAL NEEDS

Improvement in Paraspinal Muscle Tone, Autonomic Function and Quality of Life in Four Children with Cerebral Palsy Undergoing Subluxation-Based Chiropractic Care: Four Retrospective Case Studies and Review of the Literature

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ABSTRACT

Objective: To review the literature and present results experienced by four children with cerebral palsy who underwent chiropractic care to reduce vertebral subluxation.

Clinical Features: Four children previously diagnosed with cerebral palsy secondary to birth trauma. All four demonstrated objective evidence of vertebral subluxation.

Interventions and Outcomes: Chiropractic care directed at reduction of subluxation was undertaken. Paraspinal surface electromyography and thermography readings were taken prior to the initiation of care and approximately one month (12 visits) later. The mothers and care providers in each case monitored changes in activities of daily living and quality of life. All four children showed improvement in paraspinal muscle tone (improved symmetry and decreased amplitude) as well as a decrease in the number of levels of abnormal thermography readings. All four children showed improvement in activities of daily living including mobility, feeding, and postural control.

Conclusion: Improvement in muscle tone and autonomic function coupled with improvement in activities of daily living occurred in these four patients undergoing chiropractic care for reduction of vertebral subluxation. It is suggested that larger studies of this nature be carried out.

Key Words: *Chiropractic, Cerebral Palsy, Vertebral Subluxation, Dysponesis, Dysautonomia, Quality of Life, Surface Electromyography, Thermography, Posture*

Introduction

Epidemiology

The general consensus offered by several authors is that cerebral palsy is a term that describes children who suffer from an impaired developing central nervous system (CNS) such as neuropathological abnormality that results in a range of non-progressive syndromes of posture and aberrant motor control of movement.[1,2]

Other authors state that CP is also a sensorimotor disorder due to the coexisting cortical sensory deficits that alter proprioception and tactile sensations.[3]

Various studies report cerebral palsy to be the most common severe disability of early childhood with the worldwide incidence being every 2-4 live births.[4-6] In the United States, this equates to 10,000 babies per year being born with CP.[7] Most authors agree that the non-progressive lesion or brain abnormality in the motor cortex, basal ganglia, brainstem, cerebellum or spinal cord occur sometime during in-utero (prenatal), during delivery (perinatal), or the first 2 years of life (postnatal).[1,7] Evidence from Sweden showed that out of 241 children with CP 36% were born at a gestational age of less than 28 weeks; 25 % at 28 to 32 weeks of GA; 2.5% at 32 to 38 weeks GA; and 37% at term.[7] Recent trends demonstrate

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Figure 3. Lateral cervical x-ray, taken at start of care, showing a cervical kyphosis measuring -35cm.

Figure 4. Lateral x-ray taken two weeks later showing a 49% improvement to a +500 cm military neck.

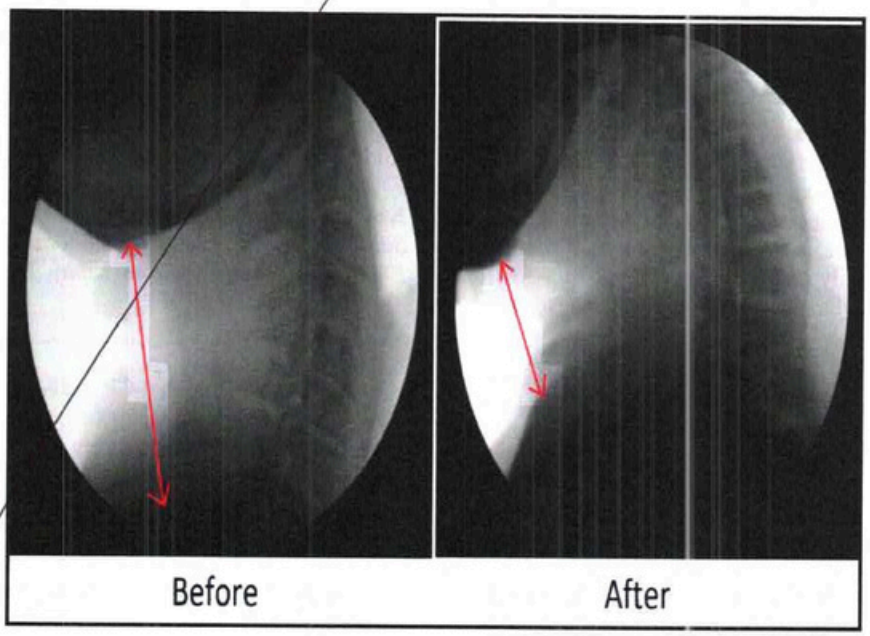


Figure 5. A still shot of video fluoroscopy taken at the start of care showing extension locks at C6, C7, T1, and T2.

Figure 6. Video fluoroscopy taken two weeks later showing the elimination of all extension locks.

an increase in the incidence and prevalence of cerebral palsy due to advances in neonatal care, improved documentation of cases by the national registries and other factors. The Centers for Disease Control estimates the lifetime cost of care for patients in the USA at $921,000 for a lifetime of care.[8]

Pathophysiology

The magnitude, extent and location of the lesion dictates the peripheral manifestations witnessed in the first 24 months of life. This leads to a vast amount of clinical presentations such as spasticity, movement disorders, muscle weakness, rigidity and ataxia. Other associated conditions can include ocular and visual abnormalities, mental retardation, varying degrees of learning disabilities, seizures, epilepsy, speech problems and hearing impairments.[9,10]

The ocular and visual abnormalities may included strabismus, refractive errors, congential structural defects, nystagmus and abnormalities of saccadic and pursuit movements, plus a defective retrochiasmatic visual pathway altering visual acuity - often seen in spastic cerebral palsy.[10] Such visual impairments and disorders of ocular motility were found to occur in 28% of children with CP.[11] Language and speech abnormalities consist of aphasias, dysarthria, poor intelligence, language development issues, aberrant integration of motor mechanisms of the oropharynx, breathing coordination problems, and alteration in the linguistic skills needed for more complex speech patterns.[1]

Additionally, there are feeding difficulties, swallowing dysfunction and drooling - all of which may lead to potential impacts on nutrition and growth. Anywhere from 30-65% of the CP population suffers from mental retardation.[12,13] Cases with spastic quadriplegia had far greater degrees of mental retardation whereas the motor deficits of spastic CP correlated strongly with the severity of cognitive impairment. Epilepsy occurs in 45% of children with CP. Children with spastic quadriplegia have incidence anywhere from 50-94%, while hemiplegia patients have 30%. Diplegia or ataxic CP only suffer 16-27%.

Ashwal et al summarized data involving 886 children with CP which demonstrated the incidence of major associated conditions.[1] Their summary concluded that 52% of these children had mental retardation, 45% had epilepsy, 28% had ophthalmologic defects, speech disorders occurred in 38% and hearing impairment in 12%. Koman et al state more than 50% of patients with CP can walk without arm assistance and 25% cannot walk.[14] Other non-neuropsychiatric problems included: gastrointestinal symptoms such as swallowing disorders, dysphagia, vomiting, gastrocsophageal reflux, enuresis, bladder hyperreflexia, detrusor sphincter as well as chronic constipation. Parks et al reported that constipation is a common finding due to a defect in gut innervation and a contributing factor is undernutrition of disabled children.[9]

The pathologic manifestations of cerebral palsy are primarily dependent upon the location of the lesion within the neuroaxis and the timing of the onset - whether it occurred prenatal, perinatal or post-natal. Prenatal cases were more likely to occur due to intrauterine infection, stroke, toxemia, and placental abruption. Perinatal conditions included: hypoxic ischemic encephalopathy, kernicterus and trauma. Postnatal onsets stemmed from infection, trauma and progressive hydrocephalus.[1,15]

Central nervous system injuries can occur in the peri-ventricular, brainstem, cortical, pyramidal or extrapyramidal systems. Other known central nervous system pathologies include hemorrhage, mechanical spinal cord or brain stem damage, as well as cerebral cortex hypoxia, and transient or irreversible ischemia - which results in cell necrosis accompanied by secondary free radical formation leading to hypoxia related cell death. The perventricular white matter is vulnerable during the 26th and 34th weeks of gestation and any fetal insult could produce periventricular leucomalacia seen in spastic cerebral palsy.[14]

In cases of diplegia the resulting injury is to the internal capsule (periventricular leucomalacia).[15] If the injury occurs in the cortical area then the reticulospinal and corticospinal tracts are involved. Such an injury would affect motor control by decreasing the number of effective motor units thus producing the aberrant muscle control and weakness, This would lead to loss of descending inhibitory input through the reticulospinal tract and other systems thus increasing the frequency of firing of the alpha and gamma pools in the spinal cord producing spasticity.

Lebiedowska described spasticity as hypertonia with a velocity-dependent increase in resistance due to the hyperexcitability of spinal motoneurons that affected the increased activation of antagonist muscles.[16] This constant spasticity can lead to musculoskeletal complaints such as contractures, pain, hip and knee subluxations, as well as peripheral nociception. Other pathologic states such as athetosis, chorea, dystonia and rigidity occur due to injury to the extrapyramidal system. The clinical manifestations stemming from the neurological injuries are dependent upon the type of CNS damage, the extent of damage and the ability of the CNS to adapt to the injury.[14]

Classification

CP is classified based on type and distribution of motor abnormalities. Koman stated that the classification is based on deformity or abnormality, anatomical distribution of the deformity and location of CNS injury.[14] The 4 types of CP are: Spastic, Dyskinetic, Ataxic and Atonic. Spastic CP is considered the most common and the most severe.

Spastic CP includes diplegia (significant leg involvement with little effect on arms), hemiplegia (ipsilateral leg and arm) and quadriplegia (all four limbs). According to DaCosta et al, spastic cerebral palsy is the most frequent and consequently has the most severe motoric impairments. They determined a high correlation between the level of motor impairment and a loss in visual acuity.[10] His group noted that the more severe the motor impairment, the greater the reduction in visual acuity.

Spastic CP can either be symmetric or asymmetric, exhibit UML signs such as hypertonia, hyperflexia and spastic hypertonia. Miller states that spastic cerebral palsy syndromes are classified according to the distribution of aberrant upper

motor neuron signs.[13] Children with spastic diplegia usually have a crouched gait that includes toe walking, flexed-stiff knees, flexed hips and an anteriorly tilted pelvis with a lumbar lordosis.[17] In cases of diplegia the resulting injury is often from an injury to the internal capsule (periventricular leucomalacia).[15]

Hemiplegic cerebral palsy is the second most common form of CP and is generally characterized by unilateral paresis and spasticity.[18] Hemiplegia is seen in babies born at term.[14] The typical posture is with the arm adducted at the shoulder, flexed at the elbow, forearm is pronated, the wrist and fingers are flexed. In the lower extremity the hip is flexed and adducted, both the knee and ankle are flexed due to increased tone in the hamstring and plantar flexor muscles. The foot tends to be in the equinovarus or calcaneovalgus position.[13]

The most severe form of spastic CP is spastic quadriplegia due to the diffuse CNS insults.[14] Spastic quadriplegia afflicts all four limbs and oftentimes dystonia is present. Associated conditions found in spastic quadriplegia include: mental retardation, little to no speech, pseudobulbar palsy causing feeding and respiratory difficulties, hip subluxations and scoliosis.[13]

Dyskinetic CP is characterized by athetosis, chorea and dystonic involuntary movements, whereas Ataxic CP is due to a genetic inheritance that causes congenital hypoplasia to the cerebellum. These children are hypotonic from birth and display delayed motor and language skills. Atonic CP occurs in full term babies and these infants are extremely slow and never stand or walk. They are profoundly mentally retarded, and suffer from cerebral dysgenesis and microcephaly.[13]

Gait

A new paradigm based on normal gait, pathologic gait and gait disruptions has emerged from the clinical orthopedic community for the management of CP. This paradigm shift led to an understanding of the kinematic and morphological adaptations of gait in spastic CP.[19] Several studies have investigated how energy-generating and energy-conserving capabilities are related to kinematic and mechanical energy patterns. Fonseca et al concluded that children with CP assume a gait similar to an inverted pendulum on the non-affected limb and a pogo stick on the affected limb - creating muscle co-contraction, plantar flexed foot at initial contact.[20] Aiona et al stated that diplegic children have flexion of the knee in midstance while normal children in midstance activate the quadriceps for full knee extension. In children with CP this leads to more work by the quadriceps in order to prevent the knee from collapsing.

So the CP patient ends up walking with excessive knee flexion thus producing increased patellofemoral contact stress leading to increased anterior knee pain.[21]

Davids et al state that pathomechanics of various gait deviations are disease specific.[22] In CP children the pathologic gait often has primary, secondary and tertiary deficits. The primary deficit is associated with the underlying disorder of the CNS causing spasticity, impaired balance and muscle control.

The most common musculosketetal abnormality in CP patients is equinus deformity. Equinus deformity is caused by a fixed or spastic contracture of the gastrocnemius and causes toe heel gait. As the spasticity increases, the ankle will remain in plantar flexion and the heel ends up never contacting the ground.[23] Secondary deficits deal with the deviations that occur due to the consequence of growth and development of the musculoskeletal system.

The most common pathological gaits seen in CP children are jump gait, crouch gait, stiff gait, recurvatum gait, and in-toeing or out-toeing gait, each with their own distinct kinematic and kinetic profile.

Management

According to Koman et al, spasticity techniques are dictated primarily by the clinical manifestations. Often times these techniques are used for the treatment of musculoskeletal abnormalities such as stiffness, muscle spasticity, muscle contracture, torsional deformities, abnormal motor control and dynamic and static joint deformity.[14] For example, there are surgical procedures designed for improving ambulation of gait, decreasing pain, decreasing spasticity and muscle tone that ends up increasing pelvic tilt, hip flexion, hip adduction, internal rotation of the hip, knee flexion, ankle equinus and planovalgus deformity.

One such procedure for a CP child with ankle equinus is surgery for the plantar flexion contracture. The goal in this procedure is to lengthen the Achilles thus improving ankle dorsiflexion during midstance.[23] Unfortunately there is an increase incidence of recurrent equinus after such surgical procedures. Equinus ankle deformity is generally associated with hindfoot varus, hindfoot valgus, hallux valgus, supination or pronation of the midfoot-forefoot complex - with hindfoot and midfoot pronation being the most common.

Other procedures performed include tendon lengthening, tendon transfer, tenotomy, arthrodesis, osteotomy, and neurectomy. In cases of hemiplegia, the child suffers from equinovarus, which is spasticity of the posterior and anterior tibialis muscles thus leading to inversion and supination of the foot. This abnormality alters foot strike thus increasing pressure over the fifth metatarsal.

If the posterior tibialis muscle is found to be the principal deforming force after gait analysis, then a split tendon transfer to the peroneus brevis muscle is indicated. This transfer of tendon allows for the action of eversion of the foot thus balancing the remaining medial half. If the anterior tibialis is the culprit, then a Rancho procedure is performed. This procedure calls for the lengthening of the posterior tibialis muscle, lengthening of the Achilles tendon and a split tendon transfer on the anterior tibialis muscle.

In cases of crouched gait and knee flexion deformities the procedures performed are medial and lateral hamstring lengthening. For knee joint contractures the procedure is capsulotomy.

Chiropractic Adjustment and Manipulation in Cerebral Palsy

Barnes discusses a case of a child with cerebral palsy treated by full spine chiropractic adjustments including the use of diversified, upper cervical Toggle adjusting and pelvic "blocking" to address subluxations. Exercises and orthotics were given and follow-up after seven months indicated a reduction in radiographic mensuration findings including the femoral angles and Shenton's line. This prompted removal of braces and discharge from further orthopedic management.[24]

Another case report by Hospers reviewed a 5 year old male with cerebral palsy undergoing upper cervical adjustment. Improvement in electromyographic patterns in the cervical spine were noted as well as a decrease in contractures and wrist extensor spasms.[25]

Duncan et al reported on fifty children in a randomized controlled trial evaluating osteopathic manipulative therapy or acupuncture in children with spastic cerebral palsy. The authors report that ninety six percent of parents reported some type of improvement from treatment with the most frequent improvement being in the use of the arms or legs and more restful sleep. The authors also reported improvement in mood and bowel function in both groups.[26]

Gutmann reported on improvement in three cases of children who had disturbances in motor responses, postural development and infection undergoing manipulation of the atlanto-occipital joint. He recommended treatment of these joints in cases of birth trauma, congenital torticollis and developmental disturbances.[27]

Biedermann made similar recommendations of manual therapy following a retrospective analysis of 114 infants with a multitude of complaints including delayed motor development.[28]

Case Studies

Case Study Number One

History and Presenting Complaints

This child was an 8 year old female presenting with a medical diagnosis of cerebral palsy and left hemiparesis secondary to birth trauma. The child was prone to seizures, which were first diagnosed at 4 months of age. She suffered from tremors of the extremities, frequent urination and had visual problems and poor posture.

Previous Medical Treatment

Consisted of physical therapy procedures including massage and acupuncture. She had 2 courses of therapy twice yearly beginning around 4 months of age.

Chiropractic Care Administered

Chiropractic intervention was directed at reduction of vertebral subluxation at the levels of C1/C2, T3/T4, T12/L1 and the left sacroiliac joint. A total of 22 visits over a nine-week period of time were administered. The described levels of subluxation were adjusted on each visit according to motion palpation findings indicating the need for an adjustment. These indicators included fixation, edema, muscle spasm and splinting.

Radiographs were taken and used to rule out contraindications to adjustment. Because of bodily deformations they were not used to determine level of subluxation, for mensuration, nor to determine a correction vector.

Changes in autonomic function and muscle tone were measured via paraspinal thermography and static surface electromyography using an Insight 7000 Subluxation Station. A thermal and SEMG scan were performed before the first adjustment. A follow-up thermal and SEMG scan was performed after 6 visits and a SEMG scan was performed at her final re-evaluation nine weeks after care began.

Outcomes

General

Following chiropractic care, the parents reported that the child could sit better and was able to walk upright without anyone's help. She gained the ability to walk up stairs on her own and she was able to use her left arm and hand better, especially when feeding herself. The child's gait became steadier, more confident and she was less "limp." It was noted that her overall coordination improved and the parents reported an increase in energy and that her emotional state improved. She was additionally less fatigued and needed less sleep and the tremors lessened in severity.

Chiropractic Examination Findings - Outcomes

There was a noted increase in intersegmental mobility at the subluxated levels and a decrease in perceived muscle spasm. Overall improvement in postural control and mobility were observed by the care givers.

Objective Outcome Assessments - SEMG

The initial SEMG scan demonstrated significant muscle hypertonicity in the cervical and upper dorsal region with the most significant at the level of C3. Hypertonicity was shifted to the left in the cervical and upper dorsal region and shifted to the right in the transitional area of T10 through L2. (See Figure 1)

A follow up SEMG scan (Post # 1) performed 11 days after the first demonstrated a reduction in the extent of the hypertonicity in the cervical and upper dorsal region with maintenance of the shift in hyperactivity to the left. While the lower dorsal and lumbar region demonstrated an increase in tone there was more balance from right to left. (See Figure 2)

A final SEMG scan was performed 46 days following the first scan and demonstrated normal readings along the left side from C7 to S1 and normal readings along the right paraspinal musculature from T6 – T10. There was an increase in hypertonicity at the level of C3 comparable to the original scan - however, overall the cervical and upper dorsal region

showed further reduction in hypertonicity more towards normal. There was an overall shift to the left in tonicity and an increase in the tonicity of the lower lumbar paraspinal musculature on the left. (See Figure 3)

SEMG scanning in this case demonstrated progressive reduction in dysponesis throughout the care plan.

Figure 1 - Case 1 SEMG – Pre

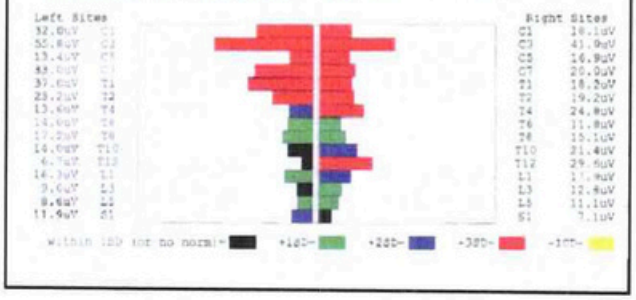


Figure 2 - Case 1 SEMG - Post 1

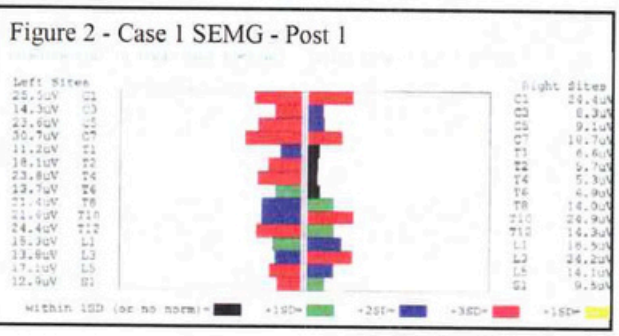
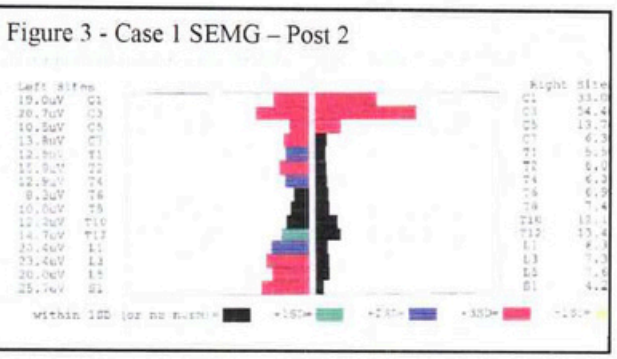


Figure 3 - Case 1 SEMG – Post 2



Objective Outcome Assessments - Thermography

The initial thermographic scan revealed a marked dysautonomia evidenced by autonomic dysfunction at all but two levels – C1 and S1. The majority of the levels were at +3 standard deviations and all but the C1 and S1 levels were shifted to the right. (See Figure 4)

Follow-up and final thermographic scanning performed 11 days after beginning chiropractic intervention revealed only 6 levels of significant autonomic dysfunction – 4 in the cervical region and 2 in the upper lumbar region. The most significant region was upper cervical and correlated with the upper cervical dysfunction noted on the SEMG as well as palpation findings. (See Figure 5)

Figure 4 - Case 1 Thermal - Pre

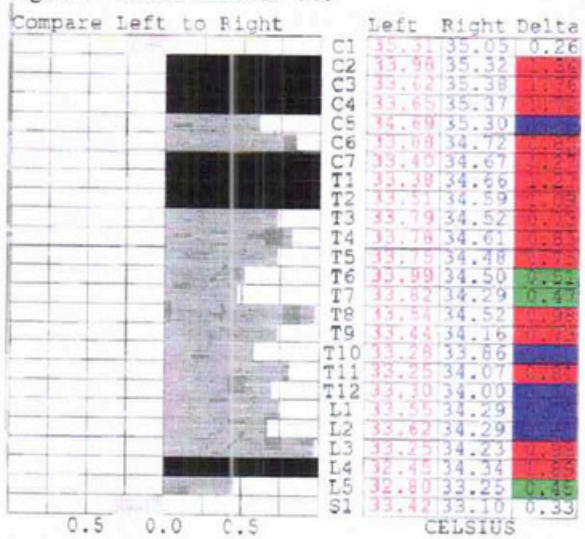
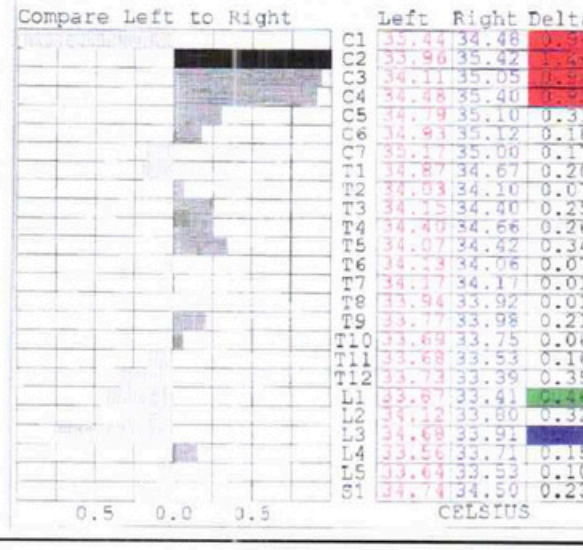


Figure 5 - Case 1 Thermal – Post



Case Study Number Two.

History and Presenting Complaints.

This child was a seven year old male presenting with a medical diagnosis of cerebral palsy and spastic tetraparesis secondary to birth trauma. He also suffered from seizures.

The mother reported that the pregnancy was a difficult one with a constant threat of miscarriage. The child was born at 7 months, had asphyxia and had to be resuscitated. The parents report that it took two minutes to revive him. He was diagnosed with an intracranial hematoma. Parents report that the only treatment they are aware of following delivery was that oxygen was given for two days. After four days the child became jaundiced and had a blood transfusion.

The parents reported that as an infant the child did not move much and that he seemed to lack any emotion. The child did not start to crawl until 11 months of age and did not start to

walk until 3 with help. He began to walk on his own at 4.5 years of age. The parents also reported that the child suffered from frequent colds, numbness and pain in the arms and legs, seizures, nasal bleeding, throat pain, hoarseness of the voice, pain in the gums and teeth, rhinitis, extremity tremors, pain in the feet, and anemia. He had trouble sleeping, difficulty communicating, concentrating and working in school. He had a poor appetite and his emotional affect continued to be a concern.

Past Medical Treatment

Prior medical treatment consisted of courses of physical therapy, paraffin baths, massage and exercises 2-3 times yearly since infancy.

Chiropractic Care Administered

Significant postural distortions were noted during the examination as a result of the tetraparesis. There was a significant amount of spasm and tension noted by the examiner in the paravertebral musculature. The child did not report any sensation of pain during the performance of spinal palpation though he did complain of abdominal pain when attempting to lie down. He could not lie on his stomach and could not fully extend his legs in any position.

Care was directed at reduction of subluxation at C1/C2, C4/C5, T4/T6, T8/T9, L5/S1 and the right sacroiliac joint. The child was under care for a total of 9 visits over a three week period of time. The described levels of subluxation were adjusted on each visit according to motion palpation findings indicating the need for an adjustment. These indicators included fixation, edema, muscle spasm and splinting.

Radiographs were taken and used to rule out contraindications to adjustment. Because of bodily deformations secondary to the cerebral palsy they were not used to determine the level of subluxation, for mensuration, nor to determine a correction vector.

Changes in autonomic function and muscle tone were measured via paraspinal thermography and static surface electromyography using an Insight 7000 Subluxation Station. A thermal and SEMG scan were performed before the first adjustment. Follow-up thermal and SEMG scans were performed after 6 weeks.

Outcomes

General

The parents reported that following the introduction of chiropractic care he became more stable while standing and walking, had greater mobility and better balance of the upper part of the body. The abdominal pain and related problems with lying on his belly and extending his legs resolved. Parents reported that he was able to walk longer distances before tiring. His abilities in school improved and his sleeping problems resolved. They reported that his appetite, communication and emotional state improved.

Chiropractic Examination Findings - Outcomes

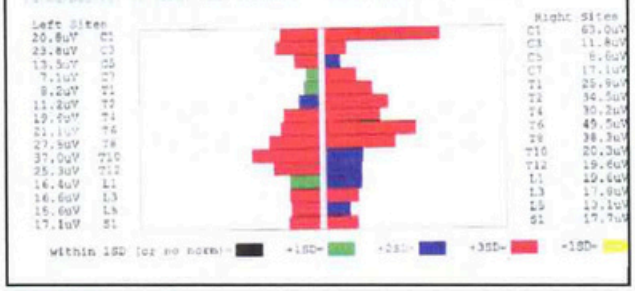
The examiners perceived improvement in posture, range of motion and gait. There was a perceived increase in intersegmental mobility and a decrease in spasm at the levels of subluxation.

Objective Outcome Assessments - SEMG

The initial paraspinal SEMG revealed significant dysponesis. All vertebral levels except for T12 on the left demonstrated a + 3 level of hypertonicity bilaterally.

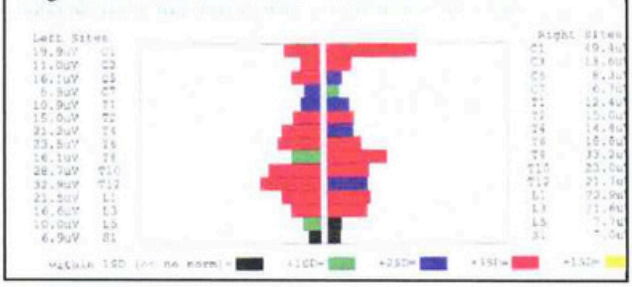
There appeared to be an alternating balance regarding the shifting of this tonicity from left to right. The most significant areas of hypertonicity were upper cervical, mid dorsal and lower lumbar. (See Figure 6)

Figure 6 – Case 2 – SEMG - Pre



Follow up and final SEMG paraspinal scanning revealed a marked improvement and decrease in hypertonicity throughout the entire spine. The scan demonstrated a more normal pear shaped pattern consistent with normative data. The scan demonstrated nine levels of + 3 standard deviations as opposed to 15 and the magnitude of the remaining were reduced. The most significant areas of hypertonicity remaining were at C1 and the lower dorsal regions. There was significant improvement in side to side balance overall. (See Figure 7)

Figure 7 – Case 2 – SEMG – Post



Objective Outcome Assessments - Thermography

The initial thermographic scan revealed a marked level of dysautonomia with 15 out of 25 levels exhibiting abnormality. The most significant area was the cervical region. The scan demonstrated an overall shift to the right. (See Figure 8)

Follow up scanning revealed only two levels demonstrating abnormality – C4 and T2, though temperature remained shifted to the right. There was significant reduction in

dysautonomia which correlated well with the SEMG, other chiropractic findings and patient outcomes. (See Figure 9)

Figure 8 – Case 2 – Thermal – Pre

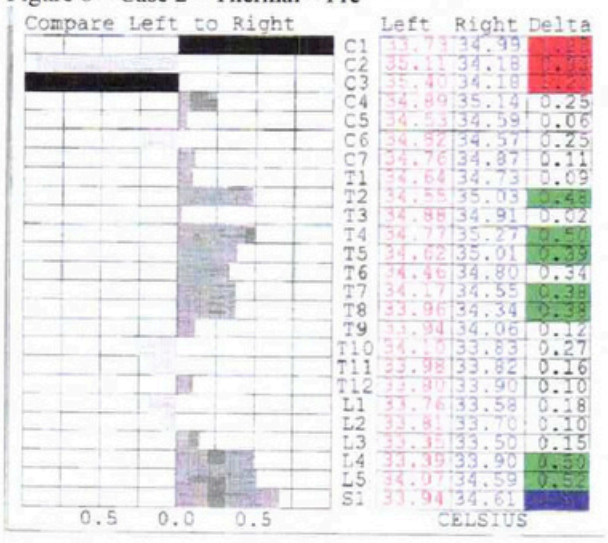
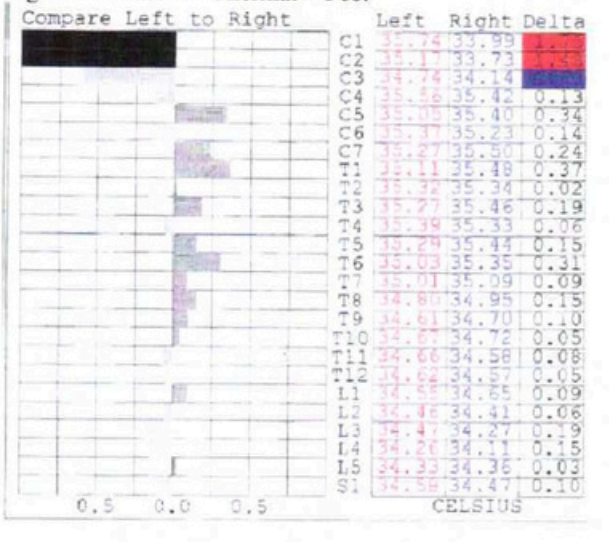


Figure 9 – Case 2 – Thermal – Post



Case Study Number Three

History and Presenting Complaints

This patient was a twelve year old boy medically diagnosed at 9 months of age with cerebral palsy secondary to birth trauma. He was also diagnosed with a left torticollis following delivery. At five months he had a CT scan performed and the parents were told he had an intracranial hemorrhage at birth. His mother reported that there was a "constant threat of miscarriage" during the pregnancy from the 8th to the 12th week. The child was not premature.

He had ongoing problems with inability to turn his head from one side to another and this precipitated the cerebral palsy diagnosis at 9 months of age. The child started to walk at 1 1/2 years of age but only with help. He began to walk on his own at 2 years of age. He started to talk at 7 months. He had trouble walking, as he could not walk on his heels. He had already had surgery for this on the Achilles' tendons bilaterally and another was scheduled in the future. The boy had trouble with sleeping, concentration in school and lacked an appetite. His emotional affect was depressed according to his mother.

Past Medical Treatment

Previous medical treatment consisted of a few courses of massage, physical therapy and manual therapy.

Chiropractic Care Administered

Chiropractic care was directed at reduction of vertebral subluxation at the levels of C/1/C2, T2/T3, T4/T5, T10/T11 and the left sacroiliac joint. The child was under care for a total of 12 visits over a four week period of time. The described levels of subluxation were adjusted on each visit according to motion palpation findings indicating the need for an adjustment. These indicators included the presence of fixation, edema, muscle spasm and muscle splinting upon digital palpation.

Radiographs were taken and used to rule out contraindications to adjustment. Because of bodily deformations related to the cerebral palsy they were not used to determine the level of subluxation, for mensuration, nor to determine a correction vector.

Changes in autonomic function and muscle tone were measured via paraspinal thermography and static surface electromyography using an Insight 7000 Subluxation Station. A thermal and SEMG scan were performed before the first adjustment and follow-up scans were performed after 4 approximately weeks of care.

Outcomes

General

After the introduction of chiropractic care the boy's mother noticed improved changes in his coordination of movement, especially related to his lower extremities while standing and walking. His gait improved and he was able to step on his heels as he walked. Problems with sleep resolved along with an increase in appetite, improved concentration and emotional health.

Chiropractic Examination Findings - Outcomes

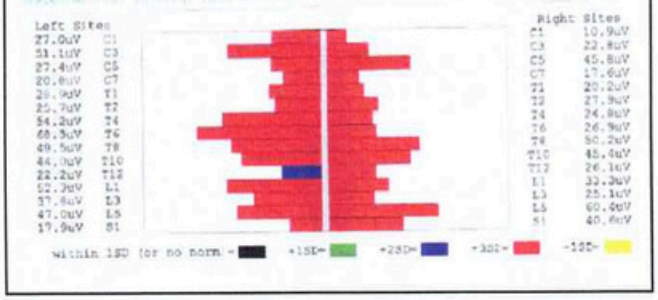
The examiner reported a perceived increase in intersegmental motion of the subluxated segments along with a decrease in spasm at these levels. Posture and gait were noted to have improved and there was less tension in the Achilles' tendons bilaterally.

Objective Outcome Assessments - SEMG

Initial paraspinal surface electromyography scans revealed +3 standard deviations of paraspinal hypertonicity throughout the cervical, dorsal and lumbar region. The scans reflected a criss-cross pattern of increased tonicity. The most significant levels

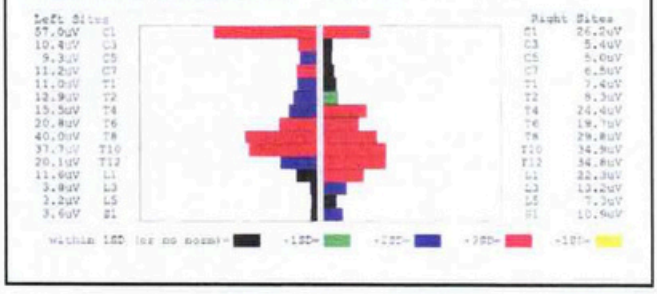
included the upper cervical region at C1 with a shift to the right. There were associated levels of increased tone on the left cervical region which crossed over to the right in the lower cervical to mid dorsal region with the most significant level at T6. The pattern then crossed to the left from the lower dorsal to upper lumbar. The lumbar region generally exhibited bilaterally equal hypertonicity. (See Figure 10)

Figure 10 – Case 3 – SEMG – Pre



Follow up SEMG readings 4 weeks after care began demonstrated a more normal pear shaped pattern to the paraspinal muscular tone. Overall the magnitude of the hypertonicities reduced especially in the lower cervical and upper dorsal regions. The patient continued to exhibit significant levels of hypertonicity in the upper cervical region though the amplitudes were decreased overall. A criss-cross pattern was not as apparent and the scan appeared more balanced. (See Figure 11)

Figure 11 – Case 3 – SEMG – Post



Objective Outcome Assessments - Thermography

Initial paraspinal thermographic scanning revealed severe areas of dysautonomia in the upper cervical region and mild areas in the upper and mid dorsal and lower lumbar region. (See Figure 12)

Follow-up thermograhic evaluation revealed a normal scan with the exception of the upper cervical region which continued to exhibit severe levels of dysautonomia. (See Figure 13)

Case Study Number Four

History and Presenting Complaints

This was a 10 year old female with a medical diagnosis of cerebral palsy secondary to birth trauma. The diagnosis was made when she was one year of age. Her mother reported a history of frequent colds, visual problems that were getting worse, crossed eyes, extremity tremors, and enuresis. Her

Figure 12 – Case 3 – Thermal – Pre

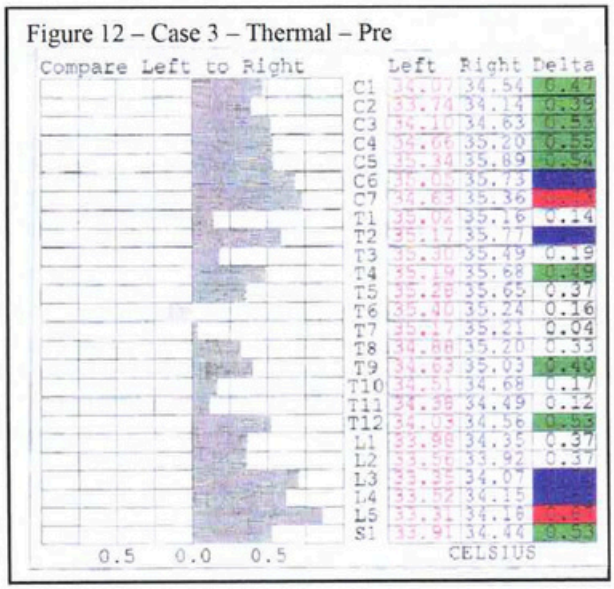
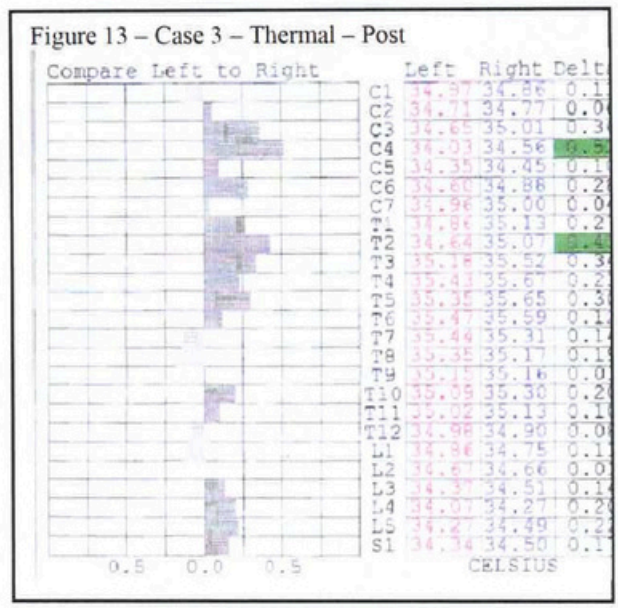


Figure 13 – Case 3 – Thermal – Post



mother also expressed concern about the child's bad posture, deviation of the spine, and pelvic imbalance. Her mother reported that the child was irritable and constantly pushed limits at home and in school and needed constant discipline. She noted that the child had a depressed affect.

Previous Medical Treatment

Since the time of the diagnosis the girl had regular courses of treatment on the order of 2-3 times a year that consisted of massage, acupuncture and exercises.

Chiropractic Care Administered

Chiropractic care was directed at reduction of vertebral subluxation at the levels of the occipito/atlanto/axial articulations, T1/T2 and the left sacroiliac joint. The child was under care for a total of 12 visits over a four week period of time. The noted subluxations were adjusted on each visit according to motion palpation findings indicating the need for

an adjustment. These indicators included fixation, edema, muscle spasm and muscular splinting secondary to digital palpation.

Radiographs were taken and used to rule out contraindications to adjustment. Because of bodily deformations due to the cerebral palsy they were not used to determine level of subluxation, for mensuration, nor to determine a correction vector.

Changes in autonomic function and muscle tone were measured via paraspinal thermography and static surface electromyography using an Insight 7000 Subluxation Station. A thermal and SEMG scan were performed before the first adjustment and follow-up scans were performed after 4 weeks of care.

Outcomes

General

After the introduction of chiropractic care the patient's mother reported, and examiners noted improvement in, the child's posture, decreased asymmetry of the shoulder girdle, the girl no longer had a stooped posture and her hips became level. It was easier for her to stand erect and according to the mother she became less irritable and less depressed. Her tremors lessened as well.

Chiropractic Examination Findings - Outcomes

The examiner reported a perceived increase in intersegmental motion of the subluxated segments along with a decrease in spasm and edema at these levels. Posture, gait and global range of motion were noted to have improved. The examiner noted that the child became less fidgety as care continued and was able to ambulate better and maneuver on the adjusting table easier.

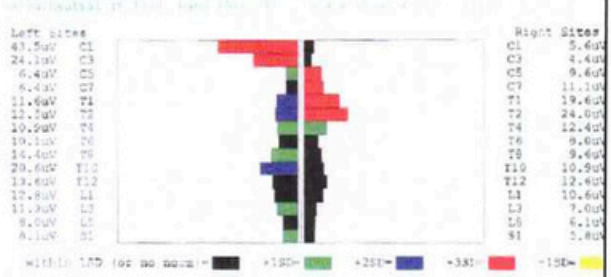
Objective Outcome Assessments - SEMG

The intial paraspinal surface electromyography scan revealed severe levels of dysponesis in the entire cervical and upper dorsal spine bilaterally with a shift to the right overall. The remainder of the paraspinal musculature was dramatically less hypertonic though there were several levels of mild to moderate areas of increased tone. (See Figure 14)

Figure 14 - Case 4 – SEMG – Pre

Follow-up scanning 4 weeks after the initiation of care demonstrated a marked decrease in dysponetic activity throughout the spine and especially in the cervical and upper dorsal region. There appeared to be a more pear shaped pattern of tonicity throughout the spine and a criss-cross pattern of hypertonicity in the cervical and upper dorsal regions emerged. (See Figure 15)

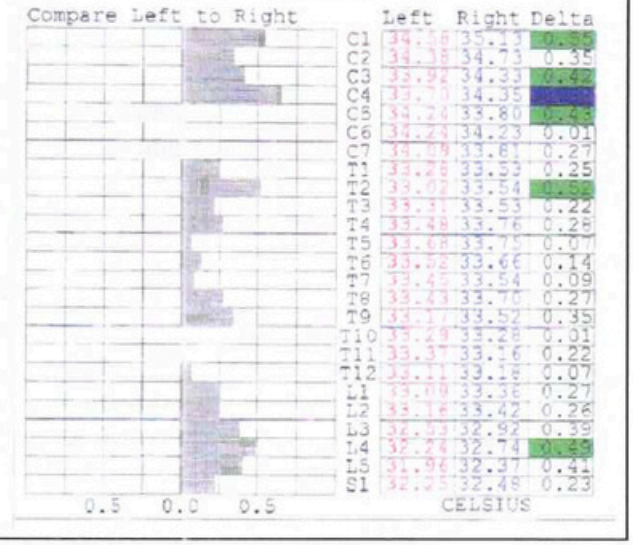
Figure 15 – Case 4 – SEMG – Post



Objective Outcome Assessments - Thermography

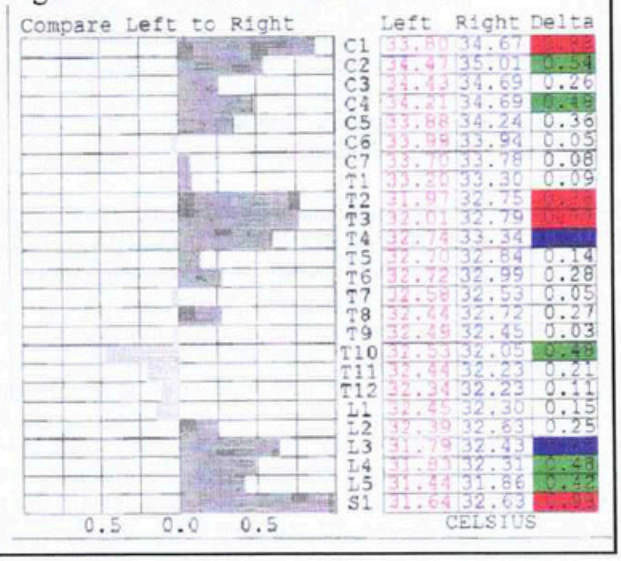
Initial thermographic evaluation revealed 5 levels of mild and one level of moderate dysautonomia. The majority of these were clustered in the cervical spine and shifted to the right. (See Figure 16)

Figure 16 – Case 4 – Thermal – Pre



Follow-up scanning demonstrated an overall increase in dysautonomia with 4 levels of severe, 2 levels of moderate and 5 levels of mild readings. These were spread out throughout the cervical and lumber spine with clusters in the upper cervical, upper dorsal and lower lumbar region. (See Figure 17)

Figure 17 – Case 4 – Thermal – Post



Discussion

All of the children reported on in these four retrospective cases experienced an improvement in their quality of life following the introduction of chiropractic care.

In his paper on the effects of chiropractic intervention on asymptomatic subjects, Hannon reviewed a number of studies reporting on objective improvements in physiological function. Besides improvements in such areas as cardiac and pulmonary function, immune system effects, and cognitive changes - positive improvements in range of motion, muscle strength and other neuromusuloskeletal parameters have been documented in the literature.[29] The findings regarding improved physiological function in the literature are consistent with the findings in the cases of these four children.

In addition to the reported improvements in activities of daily living, function, and emotional stability in these patients, there were also objective improvements in neurological function. These parameters were measured utilizing paraspinal scanning surface electromyography and paraspinal thermography.

A brief discussion of thermal scanning, paraspinal SEMG scanning, and their clinical interpretation follows.

Thermal Scanning

Alterations in skin temperature patterns are associated with aberrations in the function of the autonomic nervous system. The autonomic nervous system controls the organs, glands, and blood vessels. It is responsible for relating the internal environment of the patient to the dynamics of the outside world. One important function of the autonomic nervous system is temperature regulation. When the outside environment is cool, the body will attempt to conserve heat, resulting in constriction of the arterioles in the skin. When the outside environment is warm, and the body seeks to eliminate heat, vasodilation of the arterioles in the skin will result.[30]

In a healthy patient, skin temperature patterns will be constantly changing, but symmetrical. This is because a healthy body is constantly adapting to the environment. Vertebral subluxations result in thermal asymmetries and/or fixed patterns. The levels of thermal asymmetry are not necessarily the levels of subluxation, and may change with time. The value of the thermal scan is in determining the overall degree of autonomic abnormality, and the response of the patient to the adjustment.[31-38] B.J. Palmer developed and used a system of skin temperature analysis called the "pattern system." Miller described the basic premise of pattern analysis as follows:

> "Persons free of neurological interference tend to display skin temperature readings which continually change, but when the vertebral subluxation and interference to normal neurological function appear on the scene, these changing differentials become static. They no longer display normal adaptability, and at this time the patient is said to be `in pattern.'" [32]

Two mechanisms have been proposed which relate to altered skin temperatures: the segmental and the nonsegmental.

The segmental model

According to the segmental model, sensory irritation via the recurrent meningeal nerve may result in a sympathetic response of vasoconstriction. This will produce thermal asymmetry in the "thermatome" affected. A thermatome is similar to a dermatome, but refers to a region of temperature change rather than sensation. When this mechanism is operative, the level of the thermal asymmetry is often the same as the level of subluxation, or is close to it. Some clinicians report that chronic subluxations or long standing organic disease may be associated with segmental responses. Segmental facilitation of the lateral horn cells of the spinal cord may produce similar changes.

The non-segmental model

Sensory innervation of the intervertebral discs and facet joints is not only segmental, but is also non-segmental through the paravertebral sympathetic trunk. Therefore, a subluxation at any level of the spine may produce thermal changes throughout the entire spine. Depending up on the degree of chronicity, these changes may be fluctuating or "fixed" into a pattern.

Clinical analysis - thermography

In the analysis of thermal differentials, we are concerned with two factors, symmetry and pattern. Symmetry refers to the

difference in temperature between the left side and the right side at like points along the spine. It has been demonstrated that specific temperatures vary greatly from person to person. Actual temperatures also vary in the same person from moment to moment. However, the differences in temperature from side to side are maintained within strict limits in healthy persons.

Uematsu et al determined normative values based upon 90 asymptomatic "normal" individuals. These authors stated: "These values can be used as a standard in assessment of sympathetic nerve function, and the degree of asymmetry is a quantifiable indicator of dysfunction...Deviations from the normal values will allow suspicion of neurological pathology to be quantitated and therefore can improve assessment and lead to proper clinical management."[39]

These values were incorporated into the Insight 7000 software – the software used in these cases. Mild, moderate, and severe asymmetries are identified by color bars. Temperature differences between one and two standard deviations indicate a mild asymmetry; two to three standard deviations a moderate asymmetry; while three or more are indicative of a severe asymmetry.

It must be remembered that since vasomotor activity should be a dynamic process, the levels of asymmetry will change from session to session unless a chronic subluxation is present. Even though the levels change, a patient with acute or subacute subluxation will usually have approximately the same number of levels out of range, although the levels themselves may change.

The thermal sensors, when properly used, provide excellent reliability (reproducibility) of temperature measurement. However, temperature patterns on a patient change from moment to moment unless chronic subluxation is present. This may incorrectly lead the examiner to believe that the instrument or procedure is not reproducible. Reproducible readings indicate chronic subluxation. This is *not* a normal or desirable state of affairs.

Paraspinal Surface Electromyography

SEMG and Vertebral Subluxation

Several models and definitions have been proposed for vertebral subluxation. These models have been reviewed elsewhere.[40] The definition adopted by the Association of Chiropractic Colleges[41] states, "A subluxation is a complex of functional and/or structural and/or pathological articular changes that compromise neural integrity and may influence organ system function and general health." As Lantz[42] noted: "Common to all concepts of subluxation are some form of kinesiologic dysfunction and some form of neurologic involvement." Paraspinal muscle dysfunction is generally accepted as a clinical manifestation of vertebral subluxation.[43,44] Traditional chiropractic analysis includes examination of the paravertebral tissues for "taut and tender" muscle fibres.

D. D. Palmer expressed the relationship between "tone" and the dynamics of health and disease... "Life is an expression of tone. Tone is the normal degree of nerve tension.Tone is expressed in function by normal elasticity, strength, and excitability...the cause of disease is any variation in tone."[45] Surface EMG provides objective, quantitative data concerning the changes in paraspinal muscle function that accompany vertebral subluxation. Specific clinical applications require an understanding of muscle physiology.

Muscle fibres may be functionally classified as fast twitch and slow twitch fibres. The fast twitch fibres control phasic or fast ballistic movements. Slow twitch fibres are responsible for maintaining tonic postural support.[46] However, the erector spinae muscles present some unique histological and physiological characteristics. One unusual characteristic is that the slow twitch (Type I) fibres are larger in cross section than the fast twitch (Type II) fibres. The large fibres may be recruited at lower forces than the smaller fibres, which is an unusual recruitment pattern. Furthermore, the erector spinae muscles are composed of separately innervated, independently contracting, discrete muscle fascicles. The erector spinae muscles rarely shorten beyond their length in the upright standing position. These factors must be considered when assessing EMG patterns in the erector spinae.[47]

The role of articular mechanoreceptors in producing afferent input to the CNS, and resulting reflex muscle activity, has been investigated. In the context of SEMG assessment of paraspinal muscle function, it has been suggested that articular mechanoreceptors and muscle spindles are activated during the chiropractic adjustment or "manipulation."[48,49] The resulting increase in mechanoreceptor activity is thought to result in reflex inhibition of spastic muscles in the affected area. This increased sensory input is also believed to result in reduced transmission of nociceptive signals, resulting in decreased pain perception.

Type II mechanoreceptors are dynamic, low threshold, and rapidly adapting. These mechanoreceptors fire impulses of less than 500 milliseconds in duration at the onset of tension changes in the joint capsule.[50,51] Experimental evidence demonstrates that Type II articular receptor reflex responses produce changes in the tone of associated muscles when the joint is moved. These reflex changes may be excitatory or inhibitory. It has been shown experimentally that the application of fast manipulative thrusts to the thoracic spine resulted in a brief surface EMG response in the muscles of the contralateral side.

However, the application of slow forces showed a gradual, generalized increase in the SEMG activity as the force increased.[52]

Murphy[53] summarized the neurological pathways associated with the maintenance of background postural tone: "Weight bearing disc and mechanoreceptor functional integrity regulates and drives background postural neurologic information and function (muscular) through the unconscious mechanoreception anterior and posterior spinocerebellar tract, cerebellum, vestibular nuclei, descending medial longitudinal fusciculus (medial and lateral vestibulospinal tracts),

regulatory anterior horn cell pathway." The anterior horn cells provide motor output which travels via motor nerves to muscle fibres.

Bullock-Saxton, Janda, and Bullock[54,55] have used SEMG techniques to assess subconscious and automatic responses in muscle activation patterns. Janda [56] has suggested that good function of peripheral structures, good muscle balance, and activation of the spinocerello-vestibular circuits facilitates the most important afferent pathways and centers. Whatmore and Kohi[57] described an important neurophysiologic factor in functional disorders which they termed "dysponesis."

Dysponesis refers to a reversible physiopathologic state consisting of errors in energy expenditure, which are capable of producing functional disorders. Dysponesis consists mainly of covert errors in action potential output from the motor and premotor areas of the cortex and the consequences of that output. These neurophysiological reactions may result from responses to environmental events, bodily sensations, and emotions. The resulting aberrant muscle activity may be evaluated using surface electrode techniques. In chiropractic practice, dysponesis may be associated with vertebral subluxation. SEMG techniques, therefore, are used to assess muscular responses to chiropractic adjustments.

Gentempo and Kent have published specific indications for static surface EMG scanning.[58] The examination is indicated if three or more of the following ten abnormalities are present:

1. Palpable paraspinal muscle spasm.
2. Palpable asymmetry of the paraspinal muscles.
3. Asymmetrical range(s) of motion.
4. Paraspinal muscle tenderness.
5. Muscle ache reported by patient.
6. History of trauma to the spine.
7. Diagnosis of nerve root irritation evidenced by abnormal neurological examination findings.
8. Clinical presentation of an antalgic gait or lean.
9. Diminished or asymmetrical paraspinal muscle strength demonstrated by manual or electronic testing.
10. Thermographic evidence of paraspinal muscle dysfunction.

Kent and Gentempo further maintain that the static, full spine, seated study is the initial SEMG examination of choice, and should precede any dynamic assessments. The value of dynamic assessment is that it may reveal abnormalities which are not disclosed on the static examination. Therefore, when the static scan fails to disclose abnormality in the region(s) of clinical interest, dynamic assessment may be employed for further characterization of the myodynamics of the patient.

In the case of an abnormal static or dynamic SEMG, follow up examinations should be performed to evaluate patient response to chiropractic care. Generally, such follow up studies would be performed as part of regular re-exams, typically at 10-12 visit or 30 day intervals. Follow up exams are indicated until the patterns normalize, or maximal improvement is attained. Equivocal subluxation findings, an exacerbation of the patient's condition, or a new illness or injury justify reevaluation of clinical need for the test.

Interpretation of SEMG Patterns

In chiropractic practice, the primary purpose of SEMG procedures is the quantitative assessment of subluxation-related paravertebral muscle activity. It must be emphasized that SEMG is not a "stand alone" diagnostic technique for a specific clinical entity. Rather, it is a measurement which, when taken in concert with other clinical findings, is useful in chiropractic analysis. Interpretation procedures for dynamic assessments differ from those for static scans. Normative data have been developed for static scans. Interpreting dynamic scans involves different criteria. In flexion, our primary interest is the presence or absence of flexion relaxation, as well as right-left symmetry. In extension, symmetry should be maintained. In rotation and lateral flexion, we examine for a "mirror imaging" of SEMG signal upon changing directions.[58]

Paraspinal EMG Scanning Technique

Protocols and normative data for paraspinal EMG scanning have been published in the refereed literature.[59,60] Hand held electrodes are applied to the skin of the patient overlying the spine at 15 paired sites. EMG signals are measured in microvolts (10-6 volts). A computer analyzes these signals, and compares them to a normative data base. In the interpretation of SEMG scans, three factors are considered:

1. *Amplitude.* This refers to the signal level in microvolts. The higher the signal level, the greater the paraspinal muscle activity. By comparing these readings to a normative database, elevated or decreased signals can be identified.

2. *Symmetry.* This refers to a comparison of the left-right amplitudes at each spinal level.[61]

3. *Frequency shift.* Fatigued muscle exhibits a lower mean or median frequency than non-fatigued muscle.[62-66]

Paraspinal SEMG scans, taken in concert with other examination findings, may be helpful in determining the following:

1. Asymmetrical contraction
2. Areas of muscle splinting
3. Severity of the condition
4. Aberrant recruitment patterns
5. Dysponesis
6. Responses to dysafferentation
7. Response to chiropractic adjustment

Paraspinal EMG scanning is a reliable tool for the quantitative assessment of paraspinal muscle activity. This technique, by virtue of its non-invasive application, is well adapted to chiropractic analysis, particularly in relation to recording altered paraspinal muscle activity. This use of surface EMG is of specific interest since aberrant muscle activity is generally

accepted as one manifestation of vertebral subluxation. This procedure has been demonstrated to be reliable, thus supporting its usefulness within the spectrum of chiropractic analyses. In addition, the information gained through paraspinal EMG scanning may be effectively used as an outcome assessment for chiropractic care.

Conclusion

This is a review of literature and report of four cases of children with cerebral palsy who underwent chiropractic care and experienced an improvement in quality of life, a decrease in dysponetic activity and in all except one a decrease in dysautonomia. These reports are consistent with widespread anecdotal reports of similar types of improvements and are consistent with other case reports in the literature. Given the significance of such types of improvements in the lives of these children the authors call for more extensive investigation of the effects of subluxation analysis and correction in children suffering from cerebral palsy. The authors specifically call for more judicious use of objective outcome assessments to document the severity of subluxation in these children as well as to monitor and document any reduction.

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CASE STUDY

Improvement in Sleep and Quality of Life in a Child with Cerebral Palsy Undergoing Chiropractic Care

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Abstract

Objective: To report on a female patient with cerebral palsy who presented for chiropractic care.

Clinical Features: Sixteen year old female with a history of cerebral palsy and findings of vertebral subluxation resulting in poor sleep habits and muscle spasticity. She was non-ambulatory, uncommunicative and non-responsive, and due to these complications she had been fed through a feeding tube and had a complete liquid diet since birth.

Interventions and Outcomes: Over a period of six months, a specific, conservative chiropractic adjustment regimen for the correction of vertebral subluxation was administered to the patient, explicitly the motion palpation technique utilizing a specific seated cervical adjustment. The patient exhibited a considerable decrease in sleep disturbance. Static surface EMG and thermal scanning were performed using the Insight® surface EMG and thermal scanning technology. Improvements were noted in surface EMG scanning over the six months of care and thermal scanning revealed a dynamic pattern.

Conclusion: While under chiropractic care, subjective and objective improvements resulting in physical changes for the patient and quality of life improvements within her family were documented in a patient with cerebral palsy and sleep disturbances.

Key Words: *chiropractic, vertebral subluxation, quality of life, cerebral palsy, sleep disturbance, surface EMG, thermography*

Introduction

Cerebral palsy is a disease process that does not have a specific known cause or etiology. It is described as a non-progressive motor impairment syndrome from lesions and/or anomalies of the brain and central nervous system, typically caused by birth trauma. Due to such a broad, vague definition of cerebral palsy, it is not easily diagnosed before the age of two.[1,2] According to the National Institute of Neurological Diseases and Stroke, 4,500 new cases are diagnosed in the United States every year.[3] It is also estimated that 2.5 out of every 100,000 kids are diagnosed with cerebral palsy.[1,4,5]

Another description of cerebral palsy is a disorder of the brain where it has failed to develop properly or has been damaged. Either can cause impairment to the motor areas of the brain resulting in the inability to control movement or posture. Cerebral palsy can range from very mild, manageable cases to a severe, debilitating disease where the individual has extreme cognitive, emotional, and physical dysfunction. There are multiple forms of cerebral palsy, with the most common being

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Cranial chiropractic manipulative technique[3] was performed in areas of asymmetry that also had palpatory restriction. Treatment protocols involved some of the following protocols. On the side of the low canthus and larger cranial measurement, placing thumbs over coronal suture and gently separating utilizing five grams of pressure (Webster's Coronal Suture adjusting); gently flexing the occiput looking for hypertonicity of the tissue at the base of the occiput and complimentary movement of the sacrum; and rotating the sacrum and occiput in opposite directions, looking for restriction and holding position until it softens, laterally flexing occiput and sacrum unilaterally to both the right and left looking for restrictions and holding until the tension changes (Meningeal Release Technique, as taught by Dr. Jeanne Ohm). Treatment consisted of two visits the first week, then one visit per week for 3 weeks.

Results:

Visit 1: Immediately post adjustment, patient showed improvement in focus and pupillary constriction and dilation (alternating mydriasis) slowed from every few seconds to more responsive to environment. He became attentive to the doctor's face and/or voice and overall hypertonicity decreased.

Visit 2: Patient's mother reported he had been calmer and slightly more responsive.

Visit 3: Mother reported he is cooing and more verbal, which was very unusual for him. Chiropractic evaluation found cervical range of motion, particularly rotation, had improved bilaterally. It was also noted during the examination and treatment that the child was smiling more.

Visit 4: Range of motion continued to improve along with increased responsiveness and visual tracking.

Visit 5: Allopathic visual retesting indicated tracking at age-appropriate levels at that point. Mother also reported he was beginning to consistently respond to loud noises, such as a door slamming, where prior to care he had no response. Also of significance, his cooing and smiling had notably increased.

Discussion:

An infant's interpretation of the world is achieved via his senses. Decreased auditory and occulomotor function will change an infants initial perception of the world as well as decreased stimulation of the highly innervated suboccipital muscles caused by aberrant/ restricted cervical motion. One study compared eye contact between 12 mothers and infant pairs, 5 of which were infants with DS, and noted delays in the establishment of eye contact of the children with DS.[4] The American Academy of Pediatrics Preventative Task Force July 2008 found that children who had auditory dysfunction often suffered from increased difficulty with verbal and nonverbal communication, increased behavioral problems and decreased psychosocial well-being, as well as lower educational attainment.

Conductive hearing loss can be caused by multiple reasons, including otitis media and fluids trapped behind the tympanic membrane from birth The United States has 2 million typanostomies performed yearly to treat this problem; these types of procedures increased by 35% over the decade from 1996 to 2006. Utilizing chiropractic conservative treatment[5] could not only be cost-saving measure but can purportedly improve a child's visual and auditory function, affecting a child's righting mechanisms and their ability to physically relate to their world.

Conclusion:

In this one case it appeared that chiropractic offered a possible therapeutic benefit for a child with DS who was suffering from vision, auditory and cervical spine asymmetrical function. With proper differential diagnosis and working in an interdisciplinary relationship, chiropractic could become a valuable partner in a team of healthcare practitioners treating children with this complex and diverse condition. Further research is needed to determine if other children may also benefit from specific chiropractic manipulative and cranial therapy, which may offer a viable option for improving multi-sensorial function in an infant with multiple issues.

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spastic cerebral palsy affecting 70-80% of individuals diagnosed with cerebral palsy.[6,7] Other types include: dyskinetic, ataxic, and atonic.[4] In addition, anatomical involvement can be monoplegia, diplegia, hemiplegia, triplegia, or quadriplegia.[8]

Delgado et al stated that spasticity is, "*Hypertonia in which one or both of the following signs are present: 1) resistance to externally imposed movement increases with increasing speed of stretch and varies with the direction of joint movement; 2) resistance to externally imposed movement rises rapidly above a threshold speed of joint angle.*"[9] Common complaints arising from spastic cerebral palsy are muscle spasticity and difficult ambulation. These jerky movements are characteristically caused by lesions to the pyramidal and extra pyramidal pathways.[10]

Most people diagnosed with cerebral palsy have no related noetic disadvantages or medical disorders. However, in more severe cases, it is associated with cognitive impairment, reduced intellectual capacity and development, inattentiveness to the outside world, growth deficiency, impaired vision and or hearing, abnormal sensation and perception, sleep disturbances and seizures.[6,7] It has also been noted that those diagnosed with cerebral palsy are more likely to have co-morbidities such as bladder and bowel problems such as constipation. This is often a result of insufficient nutrition which could be caused by absorption problems.[5]

There are a variety of risk factors that may cause cerebral palsy. These include: premature births, infants suffering from hypoxic – ischemic encephalopathy, infants that endure seizures and those children who have had cortical artery infarct.[1] Although there are many other risk factors to take into account, the above mentioned are the most common.[1,4,11]

Further, cerebral palsy is diagnosed in 8 - 10% of children born with low birth weight, typically occurring in children born premature. To be considered in the very low birth weight category, the child has to weigh less than 1000 grams. Many times they have problems with visual impairments, growth disorders, and respiratory problems. In the premature child and those born with very low birth weights, the most common type of cerebral palsy is diplegic.[2]

Classification

The Gross Motor Function Classification System (GMFCS) considers five different levels. Level One is the most minor and includes children who can walk and perform all activities that others in their same age range can do. However, there are limitations in speed, balance, and coordination. Level Two indicates the person can walk without assistance but is limited in advanced walking. Level Three implies they require a walking device, while Level Four suggests that they need someone else to transport them. Level Five, the most serious, includes those who cannot travel on their own. Individuals at this level have problems with trunk motion and almost no control over any other extremity movement. [12]

Case Report

Patient History

A 16 year old patient with cerebral palsy presented to the office for the correction of vertebral subluxation. She had been born three months premature, weighing only four pounds and six ounces. She had multiple congenital anomalies, including a neural tube defect and a trachea-esophageal fistula. Soon after birth, she had a right ventricular shunt placed in her heart. Then, at the age of seven, she had Harrington rods placed in her spine to fuse it from T2- sacrum. The patient was diagnosed with pneumonia and respiratory syncytial virus (RSV) on three separate occasions.

She was confined to a wheel chair and was severely physically and cognitively impaired. She was non-ambulatory, uncommunicative, and non-responsive. Due to these complications, she had been fed through a feeding tube and had a complete liquid diet since birth. She had inconsistent vocal outbursts of a screeching nature. Further, she exhibited continual writhing of her cervical spine. Her gross motor coordination was limited to sporadic reaching out with her hands.

The patient's mother was aware of the benefits of chiropractic care and how it could reduce muscle spasticity and sleep disturbances associated with cerebral palsy. The patient would typically sleep from around 10 pm and then wake up at 3 or 4 am daily, which the mother attributed to uncontrollable leg movements similar to those associated with restless leg syndrome. The patient would also wake up at several other times throughout the night. After waking up at approximately 3 or 4 am, the teenager required constant attention for the remainder of the day. As a result, sleep deprivation was causing turmoil and affecting family dynamics.

Examination

The patient was difficult to examine as a result of her spasticity and inability to ambulate or stand without assistance. Initial examination with sEMG and thermal scanning technology revealed severely increased neural output in the upper cervical and thoracic region spine and abnormally decreased neural output in the thoracolumbar region of the spine. (Figures 1 & 2) Upon visual examination and palpation, the child was found to be subluxated at C1 and C7.

Due to the patient's condition, routine postural evaluation or radiographic mensuration was not performed as they would not accurately be able to detect subluxation due to the patient's constant motion. The examiner used the Insight Millennium Subluxation Station® to assess neurological function by performing thermography and sEMG evaluations. (Figures 1-7)

The thermal scans performed did not show a reduction dysautonomia throughout the course of care but the pattern was dynamic. The patient was found to have +3 hypertonic muscles throughout the upper cervical spine indicating aberrant neural output as well as +3 hypertonic muscles in the upper thoracic spine. It is suspected that due to the Harrington rods placed throughout her thoracic and lumbar spine, the

neural output had been altered such that her muscles were hypotonic between T8-L3.

Intervention

The patient began her adjustments one week after her exam at a two adjustment per week frequency. The examiner was initially concerned because the patient was not completely capable of providing subjective findings. In addition, it was unknown whether she had the cognition to understand what was happening to her. Since the patient had been subject to many medical procedures in the past that were very frightening to her, the decision was made to begin slowly and ease her into the process of chiropractic adjustments.

The examiner feared the patient would resist future adjustments if she was aggressively adjusted on the first visit. Therefore, during the first visit, the doctor used light mobilization of the neck to allow the patient to familiarize herself with the doctor's touch. After a few visits, the doctor began moving her neck gently in a rotary and lateral bending fashion to allow the patient to become comfortable with the motions used for the adjustments. Upon the patient becoming more familiar with the doctor, light thrusts were executed, followed by more forceful adjustments to obtain an audible.

On several occasions the patient's lack of cooperation prohibited a manual adjustment, so the doctor had to use an Activator or a lighter thrust. Other days, the patient's muscle spasticity prohibited the range of motion.

Outcome

During the second visit the doctor was able to apply two manual adjustments lightly that did not result in an audible release. On her sixth adjustment, the patient's mother reported that she was sleeping normally and uninterrupted throughout the night. Subsequently, at the ninth visit, the patient had a sEMG and thermography scan repeated and improvements were observed in the sEMG readings. (Figure 7) Only mild muscle tone asymmetry was noted on the last scan. Throughout the course of care there was a decrease in number of fixations which is believed to be associated with the reduction of sleeping disturbances. The patient was able to sleep for longer hours without waking throughout the night.

Discussion

Chiropractic care is frequently utilized by parents interested in a complementary health approach as a proactive choice compared to traditional disease care. Multiple case studies have been published citing improvement in the quality of life of children with special needs. Due to reduction of subluxation, multiple reports have been cited of better quality sleep patterns, resolution of strabismus, decreased spasticity, and resolution of grand mal seizures, normalized pupillary reflex and improved vocalization.[13, 14]

Many chiropractors make use of some type of instrumentation to show patients' progress while they are under care. Several chiropractors utilize instrumentation in their practices due to the fact it offers not only an objective measure of patient outcome, but also serves as a visual aid to illustrate their progression.

One specific type of instrumentation is thermal scanning. Thermal scans are used along the length of the spine to measure paraspinal cutaneous temperature differentials from one side of the spine to the other.[15] This particular technique has been used since 1924.[16] An additional form of instrumentation is surface electromyography (sEMG), which is utilized to record the amount of muscle tension measured through the electrical activity of the musculature.[17]

In a case study described by Valente, a 2 year old African American boy with cerebral palsy showed improved sleeping behaviors as well as walking ability due to chiropractic care. His feeding schedule went from 3 times per night to only 1 time and he was able to make eye contact for a longer period of time. This particular evaluation utilized diversified technique and cranial work as treatment for the patient.[18]

A retrospective case study of four patients with cerebral palsy was done to demonstrate that the reduction of vertebral subluxation resulted in improvements in their quality of life. The four patients included: two girls ages 8 and 10, and two boys ages 7 and 12, who presented with a variety of symptoms associated with cerebral palsy such as sleeping disturbances, extremity tremors, seizures, poor posture and mobility, issues with balance, concentration in school, depression, and multiple others. After only 12 adjustments over four weeks of care each patient saw a reduction in at least three or more of their symptoms.[4]

A possible explanation for the improvements experienced by the patient could be a result of the indirect effects the adjustment had on the brain through the afferent inputs from the proprioceptive and nocioceptive structures associated with the vertebral joint complex. It is plausible when an adjustment is received that it may affect the neurology of the disc, muscle spindles and Golgi Tendon Organs of the paraspinal musculature, and proprioceptors in the facet capsule. These low threshold receptors, along with the many nocioceptive fibers found throughout the vertebral motion unit, contribute input via spinal and brainstem tracts to various CNS sites including the cerebellum, thalamus, cerebral cortex and, the hypothalamus.[19]

It is theorized that as a result of chiropractic adjustments the pituitary gland, endocrine system, and vascular system are better able to communicate with the brain, thus changing the output of the brain through better communication with the limbic cortex, intermediate lateral columns, and pre and post ganglionic sympathetic efferents.[19]

In a review of the models of vertebral subluxation, Kent described the nerve root compression model, which also supports a mechanism for improvement. In the model, it states that only 10mm Hg of pressure is required to have an effect on the nerve impulse transmission of a spinal nerve root. A 60% reduction in nerve conduction was noted after only 15 minutes of 10mm Hg was applied. In addition, total recovery was distinguished with removal of the pressure 15 to 30 minutes later.[19] Therefore, it should be understood that proper spinal alignment and motion is necessary for optimal interaction between the brain and the rest of the body. It is

also important to mention that only two of the nine adjustments administered to the patient, in this case, generated an audible release, indicating it is not necessary for an audible to be heard for neural output to improve.

Conclusion

In the above referenced case regarding the patient with severe cerebral palsy, electromyographic findings indicated improvement in muscle tone and there was a decrease in fixation at C1 as a result of regular chiropractic adjustments. Upon improvement of the vertebral subluxations, the patient and her family were able to return to a normal sleep schedule as well as enjoy improved quality of life.

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Instrumentation

A series of thermal and surface electromyography scans were performed throughout the course of care. Three thermal scans and four SEMG scans were performed.

Instrumentation revealed what appear to be consistent mid and upper cervical and thoracic spine hypertonicity and dysautonomia during the care intervals reported. The most significant area of hypertonicity is in the upper cervical region and the ongoing areas of hypertoncity are felt to be related to changes in muscle activity secondary to changes in cervical and thoracic spine due to the Harrington rod.

Follow-up Thermal scanning did not reveal a decrease in the dysautonomia in the cervical region from the initial scan although the pattern is dyanamic. Follow-up Surface Electromyography scanning revealed a decrease in hypertonicity in the upper cervical and thoracic spine and a move toward a symmetrical pattern.

Figure 1 – Initial Thermal Scan

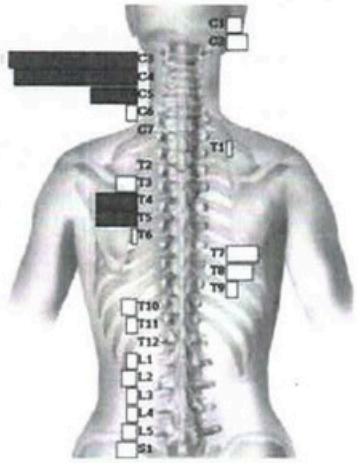

Figure 2 – Initial Surface Electromyography Scan

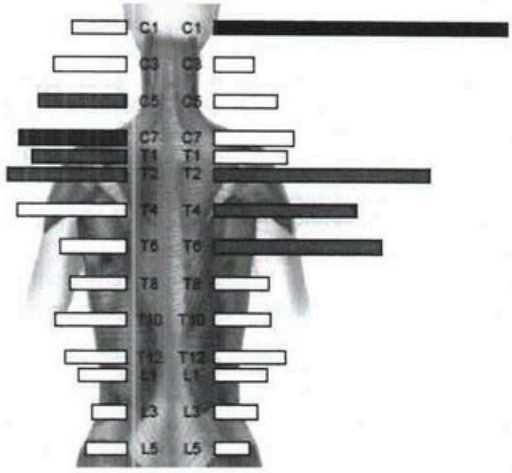

Figure 3 –Thermal Scan – 3 Months Later

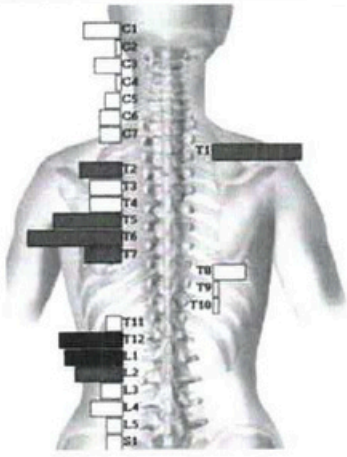

Figure 4 – Surface Electromyography Scan – 1 Month Later