The Effects of a Home-Based Connective Tissue Targeting Therapy on Hip Development in Children With Cerebral Palsy: Six Case Reports

Erika Drewes, MBChB, MMedFamMed[1,#] Mark Driscoll, PEng, PhD[2,3] Leonid Blyum, [3] and Diane Vincentz, Dipl(FH)[4]

Hip subluxation in children with Cerebral Palsy (CP) has an incidence of 10–30 %, and children with severe CP having the highest incidence. The condition deteriorates if left untreated. Surgery is the most common method used in managing hip subluxation because standard conservative therapies do not improve it. Surgery may have to be repeated and comes at a biological cost to the child. A new home-based CAM, Advanced Biomechanical Rehabilitation (ABR), has shown encouraging results leading to improved spinal stability and stability in sitting in children with severe CP. This case report examines hip development over time in six children with severe CP in the ABR Program. Changes in their clinical picture and pelvic X-Rays are reported. ABR appeared to help stabilize and improve hip subluxation, resulting in these children not requiring further surgical intervention. These findings warrant further investigation of ABR as a noninvasive therapy for hip subluxation.

Key words: cerebral palsy, ABR, hip subluxation, complementary and alternative methods

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INTRODUCTION

Hip dysplasia or subluxation is a common abnormality in hip development in children with cerebral palsy (CP) and has in this population an incidence of 10–30%.[1–6] It is most often diagnosed in children with bilateral CP and the incidence increases with the severity of the condition.[6] There are no conservative measures to prevent the development of hip subluxation in this patient population, therefore, surgery is the most common intervention used. Complementary and alternative medicine (CAM) methods are increasingly used for the treatment of CP. This case series is presented to describe hip development of children with severe CP who are part of a home-based manual CAM therapy program called Advanced Biomechanical Rehabilitation (ABR).

1 Integrative Family Physician (Private Practice), 15 Budock Road, Claremont, Cape Town 7708
2 Advanced Biomechanical Rehabilitation, Montreal, Pierre-Baillargeons, Canada 11991
3 Biomedical Research Group, 5135 Bessborough St, Montreal, Canada H4V2S5
4 Advanced Biomechanical Rehabilitation, Horndrupvej 36, Skanderborg 8660, Denmark

Corresponding author.
e-mail: Erika.drewes@me.com; erikadrewes@gmail.com

HIP DEVELOPMENT IN CP

It is thought that abnormal tensional forces around the hip joint, due to lack of weight bearing, spasticity, and contractures lead to the abnormal development of the joint and ultimately to deformities of the bony structures.[1,7,8] Typically, excessive femoral anteversion, posterolateral acetabular dysplasia, and deformation of the femoral head are observed.[7] In addition, flexion-adduction contractures contribute to the displacement of the femur head posterolaterally.[7,8] This displacement is referred to as hip subluxation. Children who never learn to sit independently, are at the greatest risk of developing subluxation that may continue to progress to dislocation if left untreated.[2,3]

Children with CP can, by the time they are three years old, be classified on one of five development curves for gross motor function (GMFSC I-V). Those who fall on the GMFSC III-V (non-ambulant) typically peak in their gross motor function development between the age of six to eight years and thereafter continue to deteriorate functionally and musculoskeletally.[9] Hip subluxation has been shown to be as high as 63% in children in GMFSC level IV or V and that the mean migration percentage per year is 9.5% for GMFSC V.[1]

Therapies such as Botulinum toxin injections and physical therapy programmes, such as bracing, have not yielded encouraging results in the prevention of subluxation.[7,10,11] Botulinum toxin also causes additional changes that impact muscle fiber growth, muscle metabolism, and extracellular matrix formation. The long-term implications of these effects are not fully understood yet.[12] Moreover, the standard neuro-rehabilitative physical therapies on offer, do not appear to prevent musculoskeletal

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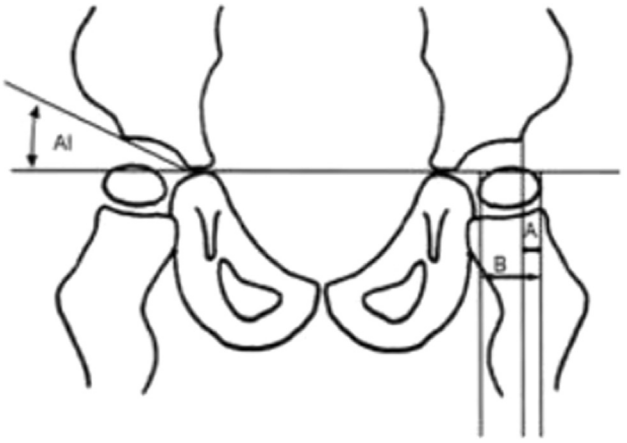

Figure 1. A line drawing showing the pelvis depicting how the MI is measured. MI is calculated as a percentage A/B multiplied by 100.

degeneration.[9] Therefore, hip subluxation is largely managed surgically.[7]

Once present, hip subluxation does not typically resolve spontaneously.[3] Untreated hip subluxation often leads to difficulty in nursing activities, poor perineal hygiene, difficulty in walking and mobililty, hip joint arthritis, and chronic pain.[1,5–7]

DIAGNOSIS, SCREENING, AND MANAGEMENT OF HIP DISORDERS IN CP

Most developed countries have instituted hip screening programmes for their CP affected populations. Hereby all children with a risk of hip subluxation are radiographed at regular intervals to assess the condition of the hip joints. The measurement of the migration index (MI) percentage has been shown to be the most accurate and effective index in determining the children who are at the greatest risk of developing hip dislocation.[13] MI measurement determines by how much the femoral head is displaced laterally and is done by calculating percentage of the femoral head area that is not covered by the acetabulum as observed in Figure 1 of an anterior-posterior pelvic X-ray[1] (Figure 1).

This measurement is reported to have the least variance between observers and is not influenced greatly by small differences in the patients' positioning at the time of X-ray.[6] Patients with femoral head displacement or MI $>$ 33%, are said to have hip subluxation.[1,13] Hip subluxation is also assessed clinically by measuring the degree of hip abduction, pain, and mobility. At least one-third of hip joints with a MI of more than 50% will progress to further subluxation,[3] while hips with an MI of between 60% and 90% all go on to dislocation.[3,4,6] Surgery is generally recommended above 33% in Europe and 40% in North America.[1,8]

SURGERY FOR HIP SUBLUXATION IN CP

Surgery for hip subluxation has evolved over the past decades from being invasive and radical procedures done later in the child's life to currently less invasive procedures (soft tissue lengthenings) done at younger ages.[8] The rationale of this approach is to prevent further subluxation and bone deformities while minimizing the biological cost to the child due to surgery.[8] Early soft tissue release surgeries have, however, been reported to result in high reoperation rates due to recurrent subluxation.[7] Selective percutaneous myofascial lengthening surgery has been reported to yield encouraging results; however, further evidence is needed.[14] In addition, these surgeries have not yet been shown to prevent joint deformities. While coverage of the femoral head somewhat improves post-operatively, acetabular remodeling does not.[5]

Studies measuring the long-term outcomes of surgery for hip subluxation are sparse and few report on hip pain outcomes and quality of life post-surgery.[4,7] Prognostic indicators for future pain due to hip subluxation also do not exist.[8] One prospective study did report significant improvement in quality of life after hip surgery,[15] but did not comment on joint pain. Other authors report that patients who had undergone soft tissue releases were just as likely, as those who had not been treated, to have pain.[7]

Long-term studies that measure improved motor function, such as sitting or walking after surgery are few.[7,14]

TISSUE CHARACTERISTICS IN CP

Connective tissue is currently being studied worldwide. Its impact on the motor function of the body was previously thought to be negligible. This view is now being challenged by new data.[16] It has been shown that connective tissue acts as a tensional, load-bearing tissue that is capable of contracting independently of muscular contraction.[16,17] The connective tissue functions within a specific mechanical tensional range. When this tensional range is physiologically optimal, the connective tissue not only plays an important role in transmitting forces between muscles, but can also adjust structurally in order to control an inflammatory environment.[17,18] In this regard, fibroblasts, the dominant cell type in the connective tissue, play a significant role. These cells have been shown to communicate with each other via gap junctions.[16] This means that connective tissue forms a mechanosensitive signaling system that penetrates the whole body to the same degree as the nervous system.[16,18]

Studies have found persistent pro-inflammatory responses in infants and children with CP compared with healthy children.[19,20] Biopsies of contracted skeletal muscle tissue in children with CP have been reported to have increased levels of various inflammatory and pro-inflammatory cytokines.[21]

Studies demonstrate that fibroblasts regulate the switch between acute and chronic inflammatory immune responses in the body.[22,23] During acute inflammation, the connective tissue typically becomes dense. If the inflammatory conditions persist, the densification becomes permanent and is then defined as fibrosis.[17,24,25] Clinically, such tissue is appreciated as being stiff and with diminished pliability.[18] Shortened and stiff connective tissue can cause pain in sensitive areas such as the areas around neuromuscular bundles when subjected to stretch. Such tissue is also weaker than healthy connective tissue, and therefore impacts motor function. Altered connective tissue mechanics