

Abstract

Introduction: Hypermobile joints display a range of movement that is considered excessive, taking into consideration the age, gender and ethnic background of the individual. Joint hypermobility may present in a single joint, a few joints or in multiple joints and may be congenital or acquired with training, disease or injury. It may be asymptomatic or may be associated with pain, fatigue, multisystemic complaints and significant disability. Furthermore, joint hypermobility may be a sign of an underlying hereditary disorder of connective tissue.

Purpose: This masterclass aims to provide a state-of-the-art review of the aetiology, epidemiology, clinical presentation, assessment and management of joint hypermobility and hypermobility related disorders using an evidence based and biopsychosocial approach. The new framework for classifying the spectrum of joint hypermobility disorders along with new diagnostic criteria for the hypermobile Ehlers Danlos syndrome, published by an international consortium of clinical experts and researchers in 2017 is integrated into the paper.

Implications for practice: People with joint hypermobility related disorder present to healthcare professionals with a wide range of symptoms which extend beyond the musculoskeletal system. Early recognition and treatment are key to effective management. A biopsychosocial approach to assessment and treatment is recommended. Patient and family education is critical so patients can actively engage in self-management and prevention of injury.

Key words: Hypermobility, Hypermobility Spectrum Disorders, Hypermobile Ehlers Danlos syndrome

Introduction

Joint hypermobility (JH) describes the ability to move a joint through a larger range of movement than is considered normal taking into consideration age, gender and ethnicity (Bird, 2007). JH is not a condition or disorder and for many it may not cause any concern and may even be an asset in performing arts and sport (Castori et al., 2017). For some people however, JH may be associated with greater risk of injury; and, for others, as well as injury, it may be associated with other systemic conditions and can be an indication of an underlying connective tissue syndrome (Castori and Hakim, 2017). Concerns arise in these conditions as a consequence of laxity and/or fragility in tendons, fascia, ligaments and bone related to the defective production or function of structural proteins such as collagen, fibrillin, elastin, and tenascin (Syx et al., 2017). These syndromes collectively are known as the Heritable Disorders of Connective Tissue (HDCT). The most common of these is the hypermobile subtype of the Ehlers Danlos syndromes (Castori et al., 2017).

This masterclass reviews the nature and assessment of JH, the criteria used to define the two most common hypermobility related disorders, Hypermobility Spectrum Disorder and Hypermobile Ehlers-Danlos syndrome (hEDS). The relationship between these conditions and other pathologies is also reviewed and evidence-based practice approach to management is discussed. Two case studies, 1 paediatric and 1 adult, are supplementary resources to assist the application to practice.

Joint Hypermobility

A number of factors can influence JH, these include age, gender, race, muscle tone, joint shape, injury, and the presence of medical disorders or syndromes that cause joint tissue laxity (Bird, 2007). Typically, children have a wide range of joint movement and this may decrease or be lost during growth and development. For this reason, scoring tools used to identify generalised or widespread JH have higher cut-off points than in adults. Similarly, adults lose mobility with age. For this reason, scoring tools used to define GJH have a lower cut-off for those after the age of 50 years (Juul-Kristensen et al., 2017).

The presentation and distribution of JH varies between individuals (Castori et al., 2017). It may be localized or mono-articular, found in just one single joint. This localised form of hypermobility may be inherited or may be acquired resulting from trauma or joint disease or relate to training. For example, knee extension range has been shown to increase with swimming training (Hahn et al., 1999) and hip range with gymnastics (Skopal et al., 2020).

JH may also be pauci-articular, i.e., identified in a few joints of the body. Moreover, it may be regional, such as upper or lower limb dominant, or in the small joints of the hands and feet (i.e., peripheral), or it may be poly-articular or 'generalised' - found throughout the body. Generalised joint hypermobility (GJH) is a more widespread feature, where increased range of movement in single or multiple planes of movement are observed in multiple joints. Interestingly GJH is observed more frequently in females and more frequently observed on the non-dominant side (Verhoeven et al., 1999).

Identify joint hypermobility

Active and passive range of movement assessments are used identify joint hypermobility. For mono and pauci articular JH there is no specific grading tool. For GJH, the most commonly used scoring tool is the Beighton scale (Beighton, 1988). The Beighton scale involves a set of 9 maneuvers which is scored out of 9 points (Table 1).

Table 1: Beighton Scale Scoring

- | |
|---|
| One point if, while standing and bending forward, the individual can place their palms on the ground with the legs straight |
| One point for each elbow that extends more than 10 degrees |
| One point for each knee that extends more than 10 degrees |
| One point for each thumb that, with the wrist flexed and arm straight, can be manipulated to touch the forearm |
| One point for each fifth finger that extends beyond 90 degrees |

Children are considered to have GJH if their Beighton score is 6 or more; adolescents and adults under the age of 50 if the score is 5 or more; and those over aged 50 if the score is 4 or more (Castori and Hakim, 2017). Another screening tool linked to the Beighton scale is the 5-part Hypermobility Questionnaire (Table 2), which has been validated for adults can be used instead of the Beighton score as quick screen for GJH. An answer of 'yes' to two or more of the questions gives a very high prediction of the presence of hypermobility, with 85% sensitivity and 84% specificity against the Beighton score (Hakim and Grahame, 2003).

Table 2. 5-Part Hypermobility Questionnaire

- | |
|---|
| 1. Can you now (or could you ever) place your hands flat on the floor without bending your knees? |
| 2. Can you now (or could you ever) bend your thumb to touch your forearm? |

3. As a child did you amuse your friends by contorting your body into strange shapes OR could you do the splits?
4. As a child or teenager did your shoulder or kneecap dislocate on more than one occasion?
5. Do you consider yourself double-jointed?

The Beighton scale is best utilized as a screening tool and it should be noted that a positive score indicates a high likelihood that an individual has GJH (Juul-Kristensen et al., 2017). A low score however does not rule out generalised or mono or pauci or regional hypermobility. Other joints should be examined for hypermobility, such as the temporomandibular joint, cervical spine, shoulders, hips and ankles to gain appropriate insight into the relationship between joint pain and injury and joint hypermobility. Two other multi planar and multi joint assessment tools are recommended for therapists. These are Upper Limb Hypermobility Assessment Tool (ULHAT) which has been validated in adult populations (Nicholson and Chan, 2018) and the Lower Limb Assessment Score (LLAS) which has been validated for both paediatric (Ferrari et al., 2005) and adult populations (Meyer et al., 2017).

Hypermobility related disorders – HSD and hEDS

The most common diagnosis of a hypermobility related disorder was previously called Joint Hypermobility Syndrome (JHS). Because of this substantial and often indistinguishable clinical overlap between JHS and hEDS (Tinkle et al., 2009) and the recognition that both JHS and hEDS can co-exist within the same family groups, the 2017 classification of EDS abandons use of the label JHS, instead considering it to be part of the clinical spectrum from generalised JH to hEDS (Castori et al., 2017). The criteria for diagnosing hEDS are shown in Figure 1. It should be noted that these new criteria are specific for adults because several of the extra articular signs (such as hernias and stria may not be present in childhood) and therefore when assessing children, clinicians need monitor signs and symptoms during growth and development to ensure the appropriate diagnosis made. The gap in diagnosis between people with symptomatic joint hypermobility who do not meet the criteria for hEDS and is now filled by the descriptive diagnosis of Hypermobility Spectrum Disorders (Castori et al., 2017). An important consideration in HSD diagnosis is the recognition of symptomatic, localized, peripheral, historic or generalised joint hypermobility.

Epidemiology and clinical presentation

The prevalence of HSD and hEDS using the new 2017 diagnostic criteria have not yet been established. However, in a large cohort trial with nested case control study in Wales the point prevalence of symptomatic hypermobility using old nomenclature was reported as

194.2 per 100 000 patients in 2016/2017. EDS or JHS was associated with high odds for other musculoskeletal diagnoses and drug prescriptions and also significantly higher odds of a diagnosis in other disease categories (eg, mental health, cardiovascular, nervous and digestive systems) (Demmler et al., 2019). In other smaller UK based studies JHS was found in 30% of adult patients presenting to a primary care clinic and 39% and 37% of adults seen in pain management and rheumatology clinics, respectively (Connelly et al., 2015, To et al., 2017). In a case controlled study in Oman, 55% of new female patients presenting to physiotherapy outpatients met the criteria of JHS while 21% were reported in the control group (Clark and Simmonds, 2011).

In both HSD and hEDS symptoms present across a spectrum of severity and initial studies are beginning to show that both can have relatively acute and mild symptoms through to chronic very complex multisystemic symptoms (Copetti et al., 2019, Russek et al., 2019). Some people are affected mostly by pain and musculoskeletal problems, others by fatigue, yet others by symptoms related to dysautonomia, gastrointestinal dysfunction, urogenital problems, autoimmune, neurodevelopmental, cognitive, anxiety and depression (Table 3). Research has also shown that patients frequently have generalised hyperalgesia and central sensitization (Scheper et al., 2017c). Pain related fear is thought to be part of the mechanistic pathway (Van Meulenbroek et al., 2020).

Some people with HSD and hEDS experience symptom flares, particularly after periods of overactivity or inactivity due to injury, illness, or stressful life events. The clinical presentation of HSD/hEDS can be further complicated by a triad of HSD/hEDS with postural orthostatic tachycardia syndrome (POTS) which is the most common form of cardiac dysautonomia and mast cell activation syndrome (MCAS). The exact reason for frequent POTS in HSD and hEDS is not clear, suggestions include peripheral vascular pooling in hyperelastic vascular structures, abnormal sympathetic activity, deconditioning and Mast Cell Activation Syndrome (De Wandele et al., 2014, Hakim et al., 2017b). The link between MCAS, HSD and hEDS is also unclear, but is proposed to be through an excess of chymase-positive mast cells affecting connective tissue (Seneviratne et al., 2017).

Table 3. Systemic Signs and Symptoms associated with HSD and hEDS

System	Signs and Symptoms
Skeletal	Joint instability (subluxations and dislocations) Persistent joint pain Scoliosis Reduced bone density
Soft tissues	Tendinitis, tendinosis, bursitis, fasciitis, tendon ruptures Muscle spasm, intramuscular trigger points Reduced strength
Gastrointestinal	Gastric reflux, nausea, early satiety after eating, abdominal pain, abdominal neural entrapment, bloating, slow transit constipation, irritable bowel, evacuation problems Rectal prolapse, hernias
Autonomic	Cardiac dysautonomia – orthostatic intolerance - low blood pressure on standing, postural tachycardia syndrome (POTS) – tachycardia with standing, dizziness, pre syncope, brain fog, fatigue, headaches, visual disturbance, exercise and heat intolerance, peripheral pooling – blotchy, purply discoloration Raynaud’s – peripheral vasoconstriction, cold hands and feet
Neurological / Neurodevelopmental	Proprioceptive deficits, frequent falls and clumsiness Developmental co-ordination disorder or delay Autistic spectrum disorder - associated sensory and social impairments Attention deficit hyperactivity disorder - associated cognitive impairment Peripheral and central pain sensitization Headaches, migraines Paresthesia’s – relating to patho-neurodynamic and nerve compression
Cardiorespiratory	Mitral valve prolapse Varicose veins Asthma like symptoms Reduced cardiorespiratory fitness
Mental health	Anxiety Panic disorder Depression Memory and cognition dysfunction
Urogenital	Urinary incontinence Urinary tract infections Prolapses: Bladder, uterine, cervical Dysmenorrhea, pelvic pain, vulvodynia, painful intercourse

Immunological	Mast cell activation syndrome (MCADS), rashes, hives, chemical and food sensitivities, excessive inflammatory response, concentration problems, headache, gastric dysfunction, persistent fatigue
Dermatological	Hyperextensible skin Poor and slow wound healing Easy bruising
Multisystemic	Chronic fatigue – central fatigue

(Clark and Whittall, 2011, Castori et al., 2012, Celletti et al., 2012, Castori et al., 2013, De Wandele et al., 2013, Castori and Voermans, 2014, Scheper et al., 2014, Bulbena et al., 2015, Fikree et al., 2015, Ghibellini et al., 2015, Rombaut et al., 2015, De Wandele et al., 2016, Fikree et al., 2017, Hakim et al., 2017a, Hakim et al., 2017b, Malfait et al., 2017, Scheper et al., 2017b, Scheper et al., 2017c, Seneviratne et al., 2017, Syx et al., 2017, Baeza-Velasco et al., 2018, To et al., 2019, Kindgren et al., 2021)

Clinical Assessment

Due to the complexity and multisystem involvement, a biopsychosocial approach is recommended when assessing and managing patients with HSD and hEDS (Engelbert et al., 2017). The International Classification of Functioning Disability and Health (ICF) model provides an effective way to integrate body structure and functional impairments with functional restrictions, personal and environmental factors (Engelbert et al., 2017). See examples of this in the supplementary case studies.

Disability in HSD and hEDS is often due to pain, fatigue, or psychosocial distress and therefore each of these factors should be explored in the history (Bennett et al., 2021, Scheper et al., 2016). Childhood symptoms, such as clumsiness and coordination are also important to explore, because Developmental Coordination Disorder frequently presents in children alongside hypermobility (Kirby and Davies, 2007, Moore et al., 2019, Piedimonte et al., 2018) and can persist into adult life (Clark and Whittall, 2011). The subjective assessment should also include questions about contributing factors especially, provocative postures and activities, especially when there is no clear traumatic onset. A key domain of the hEDS diagnostic criteria (Figure 1), is a first degree family diagnosis and therefore this can also be established in the patient interview. Furthermore, the assessment should include questions about periods of inactivity due to illness or life events, as these may also trigger episodes of increased symptoms. Multi-system involvement is associated with greater disability and worse prognosis (Scheper et al., 2016). Consequently, other system involvement needs to be explored and may justify referral to gastroenterologists, cardiologists, nutritionists/ dieticians, immunologists, psychologists and psychiatrists (Russek et al., 2019).

The physical examination should be clinically reasoned in priority order, based on the patient's subjective reports. The assessment aims to identify functional limitations,

symptomatic tissues, and systems. The degree and type of JH should be assessed along with other connective tissue features of the hEDS diagnostic criteria (Figure 1). Therapists are encouraged to use the LLAS and ULHAT as suggested previously to explore more fully joint laxity. The foot posture index may provide additional insight into the foot ankle complex (Redmond et al., 2006) (Figure 2). Care should be taken when examining hypermobile joints, especially with end range evaluation as this may exacerbate pain (Simmonds and Keer, 2007). Functional limitations can be assessed using standard outcome measures based on the patient's level of function, which can range from high level athlete or performing artist to those with very limited mobility or bed bound. Therapists should be particularly attentive to quality of movement and motor control, not just outcome and function. Research suggest that people with symptomatic hypermobility have proprioceptive deficits (Mallik et al., 1994, Hall et al., 1995, Sahin et al., 2008, Scheper et al., 2017a) and decreased precision of movement correlating to the Beighton score (Soper et al., 2015), balance, postural control and gait are also often compromised (Fatoye et al., 2011, Rombaut et al., 2011b, Falkerslev et al., 2013, Bates et al., 2021).

If patients with HSD and hEDS complain of POTS related symptoms – i.e. chest pain, syncope or dizziness when moving from sitting to standing, brain fog and fatigue, a Stand Test can substitute for the formal tilt-table test. This involves recording the patient's heart rate after 5 minutes of resting supine, then at 2, 5, and 10 minutes after quickly standing still (without fidgeting); it is helpful to monitor blood pressure to rule out orthostatic hypotension (Plash et al., 2013). A rise of ≥ 30 beats per minute in adults and ≥ 40 beats per minute in children is the threshold for the diagnosis of POTS (Plash et al., 2013).

Younger children often present to clinics with pain, fatigue, or developmental delay due to poor motor control, proprioception, and strength (Fatoye et al., 2009, Fatoye et al., 2012). Candid clinical observations are key in the paediatric setting and may reveal (Alsiri et al., 2020, Fatoye et al., 2011, Rombaut et al., 2011b) genu recurvatum, pes planus, or excessive lordosis. Upper quadrant weight-bearing assessments, such as 4 point kneel, may reveal hyperextension of elbows or wrists (Figure 3). Functional strength and dynamic control in midrange can be observed during movements such as wall squats, heel raises, single leg stand, walking, bridging (Figure 4), and 4-point superman reaching. Standardised developmental assessments such as the Movement ABC and The Bruininks-Oseretsky Test of Motor Proficiency Second Edition (BOT™-2) can be used to detect development coordination disorder but might not reflect poor quality of movement which will be an important focus for rehabilitation.

Evaluation, Diagnosis and Management

Once the clinical examination has been undertaken an evaluation, diagnosis and the management plan can be made together with the patient and parents/ care givers. Genetic testing is only appropriate if one of the other forms of EDS is suspected. The second most common form of EDS is classical EDS, which has more significant skin involvement. Even though vascular EDS is not common, it is a differential diagnosis which should be considered, due to life-threatening risk of aortic or organ rupture. People with vascular EDS typically have translucent skin with prominent veins, easy bruising, and a characteristic facial appearance with prominent eyes (Malfait et al., 2017).

The 2017 diagnostic criteria for hEDS (Figure 1) have 3 criteria that must all be met: 1) generalised joint hypermobility, 2) systemic manifestations of a connective tissue disorder (and 3) exclusion of other conditions. Criterion 1, generalised hypermobility, has been described above. Criterion 2 requires that at least 2 of 3 sub-categories be met (systemic connective tissue involvement, 1st degree family history, and musculoskeletal pain or dislocations) (Malfait et al., 2017). Criterion 3 is exclusion of other conditions associated with hypermobility and may require referral for further medical testing. Young people under the age of 18 and those who have not achieved skeletal maturity may not fulfill all the hEDS criteria and should be kept under review and a diagnosis of Paediatric HSD or symptomatic hypermobility is appropriate. Adults who do not meet hEDS criteria, but who have symptomatic hypermobility can be diagnosed with HSD (Castori and Hakim, 2017). At this point, the treating therapist need to consider the degree of complexity and severity of problems and the subsequent strategies and multidisciplinary team required.

Despite the growing body of literature, there have been few high quality interventions studies reported (Engelbert et al., 2017, Palmer et al., 2021). An empowerment model of management including condition specific education and goal orientated functional rehabilitation is recommended by experts (Russek et al., 2019, Engelbert et al., 2017). Patients who fully understand their condition, triggers and reactions, and self-care strategies can more effectively manage pain and disability, and more efficiently recover from a flare-up or injury.. Research has shown that successful physiotherapy is associated with early recognition, knowledgeable therapists, effective communication and a partnership approach (Palmer et al., 2016, Simmonds et al., 2019, Bennett et al., 2021). Patient centered goals which can be developed informally or using the Patient Specific Functional Scale (Sterling and Brentnall, 2007) are a helpful way to focus rehabilitation.

Patients and parents/caregivers need to learn strategies for joint protection and avoiding activities and positions that place excessive stress on joints (Keer and Simmonds, 2011). Learning to self-manage subluxations and dislocations can prevent stressful visits to accident and emergency departments and inappropriate medications. Understanding of body mechanics and ergonomics can minimize stress to the body. Experts suggest that external joint support such as braces and splints can help protect both large and small joints for functional or recreational activities (Keer and Simmonds, 2011). One of the benefits of bracing may be through providing additional proprioceptive input through enhancing cutaneous sensory input; compression clothing, taping and orthotics may enhance proprioception (Dupuy et al., 2017). Recent research exploring the use of ring splints demonstrates improved grip strength and hand function (Shelpe et al., 2017). Moreover, adaptive utensils and tool modifications may decrease stress on hand joints. Patients need to understand when and how to use such assistive devices and occupational therapy plays a very important role for this (Engelbert et al., 2017).

Exercise therapy is a cornerstone of management and needs to address physical impairments. Proprioception and strength training have been shown to be beneficial in reducing joint and spinal pain, improving control of movement and quality of life in both paediatric (Kemp et al., 2010, Pacey et al., 2013) and adult populations (Ferrell et al., 2004, Sahin et al., 2008, Toprak Celenay and Ozer Kaya, 2017). Hypermobility people have been shown to strengthen at the same rate as non-hypermobility people, however both concentric and eccentric strength can be very reduced in those with syndromic hypermobility and therefore the prescription may need to start at a low level (To and Alexander, 2019). Closed chain exercises and augmented or external feedback using biofeedback, tape, close fitting clothing may be particularly helpful due to decreased proprioception (Lauber and Keller, 2014). Patients report that a 'hands on' approach to help guide and aid learning is beneficial from the patients perspective (Simmonds et al., 2017). When implementing strengthening programmes, progression should be slow to avoid irritating unstable joints and surrounding easy-to-irritate muscles and tendons, which respond differently to muscle activation than the non-hypermobility population. This impaired firing pattern may be related to the altered connective tissue found in the extracellular matrix of muscle fiber impacting force transmission of the contraction, along with increased elasticity of the muscle tendon complex to work against during muscle firing (Rombaut et al., 2012, Gerrits et al., 2013). Patients with HSD and hEDS often report have tight muscles (Simmonds et al., 2019). While over stretching joints is commonly discouraged in patients with hypermobility, focused stretching with the local joint maintained in a stable position can be appropriate if needed to address muscle imbalances and to reduce symptoms (Simmonds and Keer, 2007).

When prescribing exercise, clinicians should be aware that physical activity is a demanding task for the circulatory system, which is already functioning at its upper limit in patients who have with POTS. In this population, a reduced tolerance for exercise is common, with reports of post-exertional malaise and symptom aggravation due to exercise (Oldham et al., 2016). First line management for POTS involves increasing fluids and salt, avoiding triggers such as hot environments and eating large carbohydrate meals. Patients learn anti syncope maneuvers such as fist clenching and changing position when standing. Compression garments may help venous return. Experts and emerging research recommend, slow, progressive program beginning with recumbent exercises, lower extremity, and core strengthening to facilitate venous return, with a progression of cardiovascular training toward upright exercise (Kizilbash et al., 2014, De Wandele et al., 2021). Second line management involves includes medications to increase blood volume or increase vascular tone. Although medications play an important role in the management of dysautonomia, they should be viewed as part of a wide multi-system approach and reconditioning is essential. Psychological support for anxiety, pain and illness behaviour (Mathias et al., 2011; Kizilbash et al., 2014).

Recognition of the systemic issues commonly associated with HSD and hEDS by clinicians is instrumental in promoting the best possible treatment outcomes. For example, MCAS signs and symptoms such as skin reactions to adhesives and slow healing of wounds to systemic and local inflammatory reactions and severe fatigue need to be recognized, bearing in mind that they can vary daily in intensity (Seneviratne et al., 2017). Patients may also be affected by fragile skin, anxiety, cognitive fatigue, gastro-intestinal problems, incontinence and gynecological issues (Tinkle et al., 2017). It is therefore important to educate patients and families and to refer to other professionals or accommodate these issues within the physical therapy plan of care.

Pain management and managing flare ups of pain is often very difficult and patients with HSD and hEDS frequently report insufficient pain control even when on multiple analgesics (Rombaut et al., 2011a). Pain education can help patients understand their pain and how to ultimately self-manage appropriately in a way that works for them. With children, it is important that parents /carers understand how to practically manage a child in pain. For example, how to use ice, heat, bracing and pacing. Cognitive behavioral approaches targeting both parents and children are helpful in managing pain. Learning to correct body mechanics and slow and steady progression of activities can prevent overuse injuries or an inflammatory response. Cognitive behavioral approaches such as relaxation, coping skills, sleep hygiene

and rest can reduce symptoms (Bathen et al., 2013). There is very limited evidence regarding modalities for reducing pain in this population, but manual therapies, heat, ice, electrotherapy and acupuncture modalities have been reported to be helpful anecdotally (Simmonds and Keer, 2007). A recent case report demonstrates how manual therapy such as trigger point release and focused joint mobilization might be integrated into a comprehensive program for a patient with HSD/hEDS (Pennetti, 2018). Joint mobilizations should be implemented with prudence, due to laxity and sensitivity of tissues (Simmonds and Keer, 2007). Pharmacological management of pain in HSD/hEDS is beyond the scope of this masterclass. For further information about drug management readers are referred to recent papers by (Castori and Hakim, 2017, Chopra et al., 2017, Feldman et al., 2020). Regular physical activity is crucial for long-term management of both musculoskeletal and systemic symptoms. Weight management is important, especially for young people where overweight and obesity have been shown to increase the risk for musculoskeletal symptom by 11 times (Tobias et al., 2013). Physical activity needs to include cardiovascular and strengthening activities tailored to the individual's interests and capabilities. Patients have reported walking, swimming and Pilates as beneficial form of physical activity (Simmonds et al., 2019). Importantly acute and chronic training loads need careful monitoring to prevent injury in athletes (Gabbett et al., 2016). This is of particular importance during the adolescence growth spurt, a time when many hypermobile adolescents present with injury.

In summary, people with hypermobility related disorders are likely to present to health professionals with a variety of complaints involving multiple body systems. Early recognition and treatment provided by health professionals who are knowledgeable is key to effective management. A biopsychosocial assessment and functional restoration approach to treatment is recommended. Patient and family education is critical so patients can actively engage in self-management and injury prevention. Since research is just beginning to provide evidence regarding optimal interventions, clinicians will need to integrate existing research with clinician expertise and patient preference to maximize the benefit for each individual patient.

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