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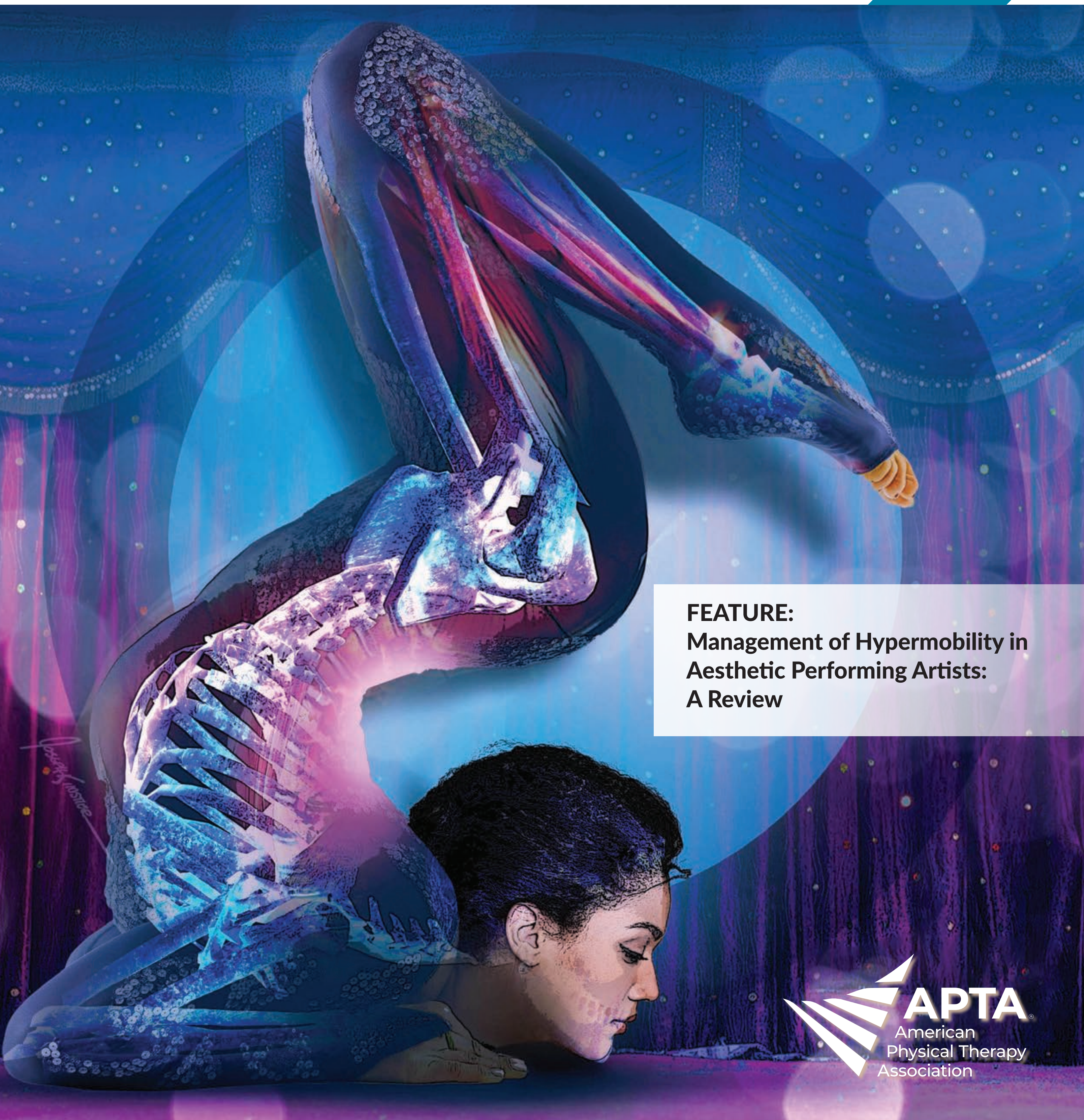
ORTHOPAEDIC PHYSICAL THERAPY PRACTICE

The publication of the Academy of Orthopaedic Physical Therapy, APTA



FEATURE:
Management of Hypermobility in Aesthetic Performing Artists: A Review

APTA
American Physical Therapy Association

Concussion Fact Sheet:

Optimize your Recovery from Concussion

What is a concussion?

A concussion is a brain injury caused by a bump, blow, or jolt to the head or body that causes the head, neck and brain to move quickly back and forth. This trauma affects thinking (confusion, feeling “off”, or in some cases a brief loss of consciousness) and may also affect the neck and the balance system. Physicians may describe a concussion as a “mild” traumatic brain injury because often no structural injury to the brain is seen.

When should I see a doctor?

If you've seen a physician to diagnose your concussion, that is good. If you haven't and are having symptoms that are bothering you, see a physician as soon as you can. If you have symptoms that persist beyond the first few weeks after injury, rehabilitation treatment may be helpful to treat those issues.

How long does recovery take?

80-90% of people with concussion will be symptom free within a few weeks. A gradual return to usual activities after a short period of rest often helps people recover. If you follow these recommendations, you will maximize your body’s ability to heal. If you have physical complaints that are slow to improve, recovery may be aided by physical therapy.

Recommendations to Speed Recovery

Activity

Rest for the first 24-48 hours. Avoid any activities that could put you at risk of additional injury. Talk with your healthcare provider about whether your occupation involves activities that present a risk for another injury. *You may not return to risky occupations until cleared by physician.*

After the first 24-48 hours, try to resume basic usual activities, including your daily routine and if you tolerate that well, school or work. There may be some rehabilitation strategies to assist in re-integration.

After 48 hours, it is okay to start light exercise again. Slowly increase intensity as your symptoms allow.

Consistent Sleep

Maintain scheduled bedtimes and awake times with no naps. Sleeping at night is the time your brain heals and napping inhibits night sleep. 7 to 9 hours of sleep at night is recommended.

Manage Stress

Perform some type of relaxation activity daily (ex. Yoga, Mindfulness, Nature walk)

Screen time - Use of computer, phone, or TV for a long time may not be good for you. You can use screen time to minimize stress if symptoms do not worsen. If symptoms worsen, take a break and resume once symptoms improve.

Eat and Hydrate

Eat a normal diet on a regular schedule. Food is fuel for the brain and is needed during this time to help repair itself.

Drink water throughout the day, 2-3 (16-24oz) bottles of water/day.

Do not drink alcohol. This may delay your brain’s healing & cause a resurgence of symptoms.

Occasionally, people may experience more severe symptoms. If you experience any of the below symptoms, call your physician or go directly to the emergency room: *Headaches that worsen significantly, slurred speech, seizures or loss of consciousness, increasing confusion, inability to awaken, severe neck pain, weakness/numbness in arms/legs, repeated vomiting, &/or unusual behavior changes.*

For more information:
Evidence Based Clinical Practice Guideline: Physical Therapy Evaluation and Treatment After Concussion/ Mild Traumatic Brain Injury
https://www.jospt.org/doi/pdf/10.2519/jospt.2020.0301

This brochure summarizes published physical therapy clinical practice guideline recommendations on concussion management. Adherence will not ensure successful outcomes for everyone, nor does it include all proper methods of care aimed at the same results. Treatment plans must use clinical data presented by the patient/client/family, the diagnosis, available treatment options, the patient’s values, expectations, and preferences, and the clinician’s scope of practice and expertise.

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In this issue

Regular features

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To serve as an advocate and resource for the practice of Orthopaedic Physical Therapy by fostering quality patient/client care and promoting professional growth.

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First 100 Days

Frequently we hear United States Presidents talk about the 100 day mark in office, which is an interesting concept. One of President Obama's top aides, David Axelrod referred to the 100 day milestone as a "Hallmark Holiday" – meaning it is a lot of attention with little significance. As I took over the role of AOPT President, I wanted to work with the AOPT Board to develop an aggressive and strong agenda that would lead to many impactful initiatives. I passed the 100 day mark on June 2nd and I am very excited and proud to share some of the initiatives that your AOPT Board has moved within this short period of time.

- We have entered into a relationship with McKinley Advisors, who I had experience working with while I served on the APTA Board and the Education Leadership Partnership (ELP). We will utilize McKinley to assist us with improving our Board governance and formation. The Board is already very strong and functioning at a high level, but this additional training is necessary for the Board to function at the highest level possible.
- The Board has voted to create a 501c3 under the umbrella of the AOPT. This will allow us to create a fundraising and philanthropic entity within our organization. There will be more to come regarding this initiative in the near future.
- Under the leadership of James Spencer, the Practice Committee has undergone a bit of restructuring. In 2021, the Board had added the Payment Work Group within the Practice Committee, so in alignment with this group we have added an Administrative Burden Work Group and a Scope of Practice Work Group. The Administrative Burden Work Group will be Chaired by Matt Hyland who is the immediate Past Vice President of APTA and Chair of the APTA Public Policy and Advocacy Committee. Therefore, Matt brings tremendous experience and expertise to this role. I have appointed Jake Magel to serve as the Chair for the Scope of Practice Work Group. We are still working to fill the roster of both groups with members, so let us know if you are interested in serving.
- We have established a Board Hub within the APTA Hub Communities to improve Board efficiency and effectiveness with our communication.
- We have implemented several strategies and modified processes to improve the efficiency and effectiveness of our work flow within our meetings throughout the year as well as within specific monthly meetings.
- In 2024, the AOPT will turn 50! Therefore, we have established an AOPT 50th Anniversary Planning Committee that will be Chaired by Bill Boissonnault.
- The AOPT Annual Orthopaedic Meeting has grossly underperformed in just about every measureable way. Therefore, the Board has established a Work Group to perform a review to determine if the AOPT should continue with an annual conference and if yes, what it should look like. Jay Irrgang has been appointed the Chair of this Work Group.
- We are still working out the logistics, but we will be implementing something new called AOPT Virtual Town Hall meetings for our members, most likely beginning in the fall of 2022. The Virtual Town Hall meetings will be quarterly and held in the evenings. More to come on this exciting new opportunity for the membership to engage with the AOPT leadership.
- Since taking office, I have been very proactive with establishing stronger collaborations and functional working relationships with other APTA Academies/Sections, including some where we may not have always had such strong relations in the past.
- The Board has engaged a Marketing Consultant to perform a thorough review of our opportunities to improve our marketing within all aspects of everything we do within the AOPT. We expect the report to be completed and reviewed by the Board at their July Board meeting.

I appreciate that this doesn't compare to President Reagan's coup of getting the hostages released from Iran within his first 100 days! However, there are many exciting initiatives that your AOPT Board has taken on and moved forward during my first 100 days in office. In addition, there are some initiatives that are in development which are guaranteed "game changers" and I am looking forward to sharing them in my next *OPTP* President's Perspective, so stay tuned!

I am happy to answer your questions and I thank you for your support as we move forward with improving the practice environment for each of you!

Best Regards,
Bob

Editor's Note

STATISTICIAN'S BLUES

by Todd Snider

"They say 3% of people use 5 to 6%
of their brain,
97% use just 3% and the rest goes
down the drain.
I'll never know which one I am,
but I'll bet you my last dime
99% think we're three percent
100% of the time."

I had the pleasure of listening to Mr. Todd Snider perform this song recently at a concert, YES, a concert! We are perhaps returning to a somewhat different life after COVID and let me tell you, it is nice to be feeling comfortable among people again. Alleluia! I feel that the beginning of Mr. Snider's song Statistician's Blues, referenced above, can easily be related to working in the clinic as a physical therapist. Specifically, the bias that we see when a patient comes into the clinic to be treated. I think we classify patients quickly in our brains to fit into a specific category because we think that patient fits in well with the 3,000 other patients that we have seen with the same clinical pattern. Croskerry and Campbell[1] identified this as "diagnostic failure" with the major source of variance in clinical performance being due to cognitive and affective bias. Croskerry and Campbell[1] describe the process of evaluating where errors occur in the diagnostic process as a "cognitive autopsy." These errors are not due to a lack of knowledge but instead are due to assumptions that the clinician makes when attempting to understand what the patient means when describing their condition or problem. I think Croskerry and Campbell's[1] ideas are important to investigate as a physical therapist seeking to improve their craft. Attempting to study clinical decision-making can only be done in the clinic. Trying to teach clinicians how to make clinical decisions using computer screens does not translate into the "real world," as my students call it. The variables that influence clinical decision-making are numerous, including cognitive load, context, fatigue, interruptions, rapid task switching required as a physical therapist in a busy practice, and the state of the clinician at the time of the examination.[1] "Corpus gathering" or the process of classifying errors in clinical decision-making, can be done by introspection and reflection.[2] How many of us can recall a patient that we now know we did not treat effectively or relate well to? The answer is, all of us can! What I am suggesting, or rather, what Croskerry has articulated well in his research agenda,[3-12] is to look back at the patient that we did not treat effectively or relate well to and investigate why this occurred. Taking a systematic approach to considering what happened or why it felt that way. Croskerry and Campbell[1] describe the difference between hindsight and hindsight bias. Hindsight is when we learn from experiences, but hindsight bias is the subconscious tendency to distort the past to make the clinician feel better about themselves about their decision-making efforts.[1] The authors speculate that if we assess systematically why we came to a clinical decision, we can eliminate our bias and learn to not make the same mistake again. If you are interested in this topic, I implore you to investigate the works of Croskerry (I have included just a few in the references for you to consider). A little self-reflection is beneficial to our professional growth. It would be a shame if our profession continued to think we were the 3% for 100% of the time! If you are interested in listening to Todd Snider's song, here is the link: https://www.youtube.com/watch?v=IUK6zjtUj00

We welcome your comments and appreciate all that you do for your patients. You can reach me at John.Heick@nau.edu

Respectfully submitted,
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Management of Hypermobility in Aesthetic Performing Artists: A Review

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ABSTRACT

Background and Purpose: Joint hypermobility is more prevalent in aesthetic performing artists than in the general population and can contribute to injury. The purpose of this review is to describe the prevalence and clinical presentation of hypermobile Ehlers-Danlos syndrome, then discuss physical therapy assessment and management of hypermobile dancers and circus artists to optimize their health and performing arts participation. **Methods:** The authors created an outline for this review to include the topics of classification, prevalence, screening, assessment, and management. PubMed, CINAHL, and Google Scholar were searched for relevant articles published in the last 20 years. **Clinical Relevance:** Clinicians need to recognize that hypermobility is more prevalent in dancers and circus artists, and actively screen for the multi-system effects. Unique strategies need to be employed to decrease injury risk and to rehabilitate the injuries that occur in these hypermobile performing artists. **Conclusion:** Physical therapists can initiate referrals for earlier diagnosis and facilitate collaborative interprofessional management for hypermobile performing artists. Appropriate management can enhance artists' ability to perform and contribute to career longevity.

Key Words: circus, dance, Ehlers-Danlos syndrome, hypermobility spectrum disorders

BACKGROUND AND PURPOSE

Hypermobility can be an advantage for performing arts aesthetics but can also increase risk of injury and other health problems such as anxiety, dysautonomia, and gastrointestinal disorders.[1] Demand for extreme flexibility in performing arts has grown over time. Competitions encourage demonstrations of extreme flexibility by awarding thrill factor points and social media platforms, such as Instagram, YouTube, and TikTok, reward feats of flexibility with likes and followers. A 60-year retrospective study of body postures in ballet, showed progressively increased leg elevation in common dance postures and shapes over time, and an association of a higher gesture leg with a more favorable audience perception.[2]

Joint hypermobility is "the capability that a joint (or a group of joints) has to move, passively and/or actively, beyond normal limits along physiological axes"[3] and considered an impairment in body structure or function.[4] Hypermobility related health conditions range from isolated joint hypermobility to heritable connective tissue disorders with multisystem involvement such as Ehlers-Danlos Syndrome (EDS). Hypermobility can be genetic (eg, Down syndrome, vascular and classical EDS) or acquired (eg, lupus, rheumatoid arthritis, or secondary to repetitive activity). Muscle weakness related to neurologic disorders and myopathies can also result in reduced dynamic joint stabilization leading to hypermobility. The purpose of this review is to describe the prevalence and clinical presentation of hypermobile EDS, then discuss physical therapy assessment and management of hypermobile dancers and circus artists to optimize their health and performing arts participation.

Prevalence

In a literature review, the authors found that hypermobile EDS has an estimated prevalence of 1-3% in the general population or 10 million in the United States, and accounts for 80-90% of individuals with EDS.[5,6] Generalized hypermobility is more common in younger children and females.[7,8] Prevalence is higher in dancers and circus artists with similar age and gender patterns.[9-14] The Beighton scale[15] is the most consistently used measure to determine prevalence of generalized hypermobility but cutoff scores vary between studies. In studies of elite ballet populations, prevalence was 74-95% in adolescents, 81% in adult pre-professionals, and 82-95% in adult professionals (Beighton score ≥ 4/9).[9,10] A study of adult professional jazz dancers showed a prevalence of 65%.[11] Prevalence in university contemporary dancers was 69% with a modified scale excluding lumbar flexion.[12] In a study comparing youth dancers ages 8-16 to matched controls, prevalence was 24% vs 8% (Beighton score ≥ 6/9).[13] Unpublished data from a study of adult pre-professional and professional circus artists shows a prevalence of 41% and 48% (Beighton score ≥ 4/9).[14] Given the higher prevalence of hypermobility among dancers and circus artists, physical therapists should regularly screen for symptomatic hypermobility, such as hypermobile EDS (hEDS) or hypermobility spectrum disorder(s) (HSD), in this population.

Diagnostic Criteria

Hypermobility syndrome, joint hypermobility syndrome, benign joint hypermobility syndrome, EDS Type III, and EDS-Hypermobility Type are former labels for a group of poorly differentiated disorders classified using the Villefranche or Brighton criteria.[5,16] In 2017, the International Consortium on the Ehlers-Danlos Syndromes defined new diagnostic criteria for hEDS: (1) generalized joint hypermobility, (2) presence of specific physical features, family history and/or musculoskeletal pain or joint instability, and (3) absence of skin fragility, other heritable or acquired connective tissue disorders, neuromuscular disorders, and skeletal dysplasias which should prompt consideration of other diagnoses.[16] Symptomatic hypermobility disorders that do not fit the hEDS criteria or another diagnostic category that could explain the patient's symptoms are now labeled HSD.[3] Across their lifespan individuals may move between hEDS and HSD classifications, and may also progress through phases characterized by hypermobility in childhood/teen years, pain in the 2nd to 4th decades, followed by stiffness.[3,5]

Hypermobile EDS is the only subtype without an identified gene mutation but is linked to autosomal dominance influenced by hormones that affect collagen, the main structural support in connective tissue.[5,16-18] This contributes to secondary musculoskeletal manifestations such as tendinopathies, subluxations and/or dislocations, scoliosis, and osteoarthritis most commonly affecting the joints at the shoulder, hip, knee, and cervical and lumbar spine.[3,19] It also affects the autonomic, cardiovascular, neurological, gastrointestinal, urogenital, integumentary, and immune systems.[3,16,18] The variability in disease presentation of hEDS and HSD, and the overlap with other disorders, can make it challenging to diagnose. It is common for patients to see several health care providers before being diagnosed with EDS. They may initially be diagnosed with an associated comorbidity or misdiagnosed with chronic fatigue syndrome or fibromyalgia.[20] A recent survey revealed that American physical therapists lack knowledge about the diagnostic criteria for generalized joint hypermobility, disease prevalence, and commonly presenting signs and symptoms other than joint pain.[21] It is important for physical therapists to increase their knowledge and understanding of hEDS and HSD.

RELATIONSHIP WITH HEALTH PROBLEMS AND INJURY RISK

Orthostatic intolerance, fatigue, headaches, joint, abdominal or pelvic pain, anxiety, and depression are common symptoms related to hEDS or HSD that often get misinterpreted or downplayed by medical professionals.[8] Orthostatic intolerance prevalence is 41-49% in hEDS.[18,22,23] Symptoms include dizziness, presyncope, syncope, headache, nausea, sweating, or changes in blood pressure upon standing or after exercise.[18,22,23] The most common type is postural orthostatic tachycardia syndrome (POTS), which is characterized by chronic orthostatic symptoms, a 30-40 beats per minute heart rate increase upon standing from a lying position without orthostatic hypotension.[18,24] Mast cell activation syndromes (MCAS) are found in 24-66% of patients with hEDS.[18,19,25] Clinical presentation varies due to multisystem effects resulting in recurrent allergy-like responses of the skin, gastrointestinal tract, neuromuscular tissues, airways, cardiovascular, and central nervous systems.[5,18,26] Cardiac disorders due to collagen abnormalities (eg, mitral valve prolapse) are also associated with hEDS and HSD.[19] Gastrointestinal disorders (GI) such as gastro-esophageal reflux, nausea, vomiting, irritable bowel syndrome, constipation, and bloating are also common (prevalence 46-86%) and can contribute to nutritional deficiencies[19,27,28] that can impact energy availability for training, fatigue, and healing.

In a large study of patients with EDS, 98% of those with hypermobility type reported pain.[29] Earlier in the disease course, nociceptive pain due to joint subluxation/dislocation, arthralgias, myofascial, or visceral pain are common.[30] Later, a widespread and centralized pain presentation becomes more characteristic.[30] Abdominal pain prevalence is 83-93% with joint hypermobility.[28] Causes include dysautonomia, GI tract collagen laxity, constipation, pelvic prolapse, and dysmenorrhea, such as endometriosis or polycystic ovaries.[8,30] Headache causes are multifactorial including neurogenic, vascular, or musculoskeletal sources, such as temporomandibular and cervicogenic dysfunction.[19,30,31] There is also a strong association of pain in EDS with depression and anxiety.[32,33] Behavioral changes such as kinesiophobia and pain catastrophizing can lead to activity avoidance resulting in deconditioning and worsening of disability.[30]

Chronic pain, poor sleep quality, deconditioning, orthostatic intolerance, nutritional deficiency related to bowel disorders, anxiety, depression, and headaches contribute to chronic fatigue in hEDS.[34,35] Prevalence of fatigue peaks in the 4th decade at 90%.[30] Involvement in athletic activity since early childhood may delay the onset.[30] Impaired joint proprioception, joint kinesthesia, and spatial awareness is also common in individuals with hypermobility.[30,36] Joint and tendon receptors rather than cutaneous receptors are the most likely cause.[37] Deficits in proprioception and muscle weakness have been associated with functional limitations.[38] When compared to matched controls, women with EDS hypermobility type had similar muscle mass, but significantly less lower extremity strength and endurance, decreased 5x sit to stand performance with pain, and fatigue exacerbated by testing.[39]

Campbell et al[40] identified hypermobility, fatigue, overuse, increased turnout, neuromuscular dysfunction, lower extremity (LE) range discrepancies, core and lower extremity weakness as 7 intrinsic modifiable risk factors associated with injury in ballet dancers. Hypermobility was associated with chronic ankle instability, anterior cruciate ligament injuries, labral tears, tendinopathies, degeneration and hip instability.[40] Dancers with hEDS might also be more likely to have the other intrinsic risk factors.[40] Joint hypermobility using Brighton criteria but not the Beighton score was correlated with injury risk in contemporary dance students.[39] Another study found significantly greater time loss from injuries in hypermobile university dance students.[41] A systematic review identified hip hypermobility as a risk factor for LE injury in youth recreational dancers.[42] In elite pre-professional modern dancers, both low and high Beighton scores were associated with higher risk of medical attention and time loss injuries.[43] However, two smaller studies of university and professional dance students, and one in professional dancers did not find an increased risk of injury for hypermobile dancers.[44-46] There is not comparable research about the association of generalized hypermobility and injury in circus but a study of injuries in professional circus students found a greater incidence of hip injuries in female students and hypothesized this was related to greater frequency of contortion skill training.[47]

PHYSICAL THERAPY ASSESSMENT AND INTERVENTION

Patient Interview and Screening for Comorbidities

With the high prevalence of musculoskeletal pain and dysfunction, physical therapists, especially those working with performing artists, are likely to encounter patients with hEDS or HSD and can play an important role in screening to facilitate early and accurate diagnosis. A thorough systems review and a review of systems are critical. The authors have created the "Hypermobility Screening Tool" (**Appendix**) for clinicians to facilitate efficient screening, earlier recognition of EDS related conditions, and collaborative interprofessional management. For example, an integumentary screening showing skin hyperextensibility with widened, atrophic scars should lead to referral to genetic testing for classical EDS.[48] The hEDS and HSD presentation varies across the lifespan, so a positive family history can guide referrals to assist with early and accurate EDS diagnoses in younger patients. For example, a family history of sudden death, thin, translucent skin, easy bruising and peripheral hypermobility of fingers and toes should indicate a need for genetic testing to rule out vascular EDS.[16]

If a patient meets the criteria for joint hypermobility using the Beighton[15] or Brighton criteria,[49] the Hypermobility Screening Tool (HST) can be used to screen for multisystem involvement, and guide referral for diagnostic testing or management. The tool will need to be validated, updated as research grows, especially to include larger and more diverse populations, and diagnostic criteria changes with improvements in molecular diagnostics. The HST includes symptoms and diagnostic labels for common comorbidities linked to hypermobility through pleiotropy, or when a gene defect affects multiple tissues, organs or structures.[3] Providers often do not recognize relationships between EDS comorbidities and diminish their importance with negative physical and mental health impacts in this population.[8,22] The authors recommend providing this checklist to the patient ahead of the visit, as it takes time to process both cognitively and emotionally, so that the patients do not disregard symptoms. The final page of the HST is a guide for clinicians to establish a health care team, or promote coordination and communication of an already established care team.

There are unique personal and environmental factors to consider in performing artists. A biopsychosocial approach, inclusive of the social and psychological domains, is helpful to capture the complex multisystemic effects of hypermobility disorders.[4] Artistic values will strongly influence their internal and external environment (**Table 1**). How do they view their hypermobility? Is it their competitive edge for standing out and attaining certain roles or is it their struggle to keep up with their peers? A performing artist may be able to perform all activities of daily living without difficulty, but do they have difficulty building the strength needed to acquire new dance or circus skills, or keeping up with the rigor of a performance rehearsal schedule? Time away from dance or circus has different implications for different artists; some can afford to step away from a recreational activity, but for others, it is their very livelihood. Performing art is a means of expression and identity; when treating a performer who has been sidelined from performing, it is very important to assess their psychological state and screen for depression/anxiety, as they may need help with coping strategies to optimize their management and return to performance. These issues are key to understanding the priorities of the performing artist and collaborating on meaningful goals for physical therapy intervention.

Physical Examination

The Beighton Score,[15] Brighton criteria,[49] and 5-point screening questionnaire[50] can be used to screen for joint hypermobility. The recently adopted International Consortium Beighton score criteria of ≥ 6/9 in pre-pubertal children, ≥ 5/9 for post-pubertal up to age 50, and ≥ 4/9 for over age 50 is currently recommended.[15-16,40] It may also be useful to examine joint hypermobility throughout the extremities or at specific joints in performing artists depending on which areas are painful or affecting function. The Lower Limb Assessment Score is a validated tool that includes the knee and ankle anterior drawer, assessment of hip, knee, ankle, foot, and great toe passive physiologic mobility, and midfoot pronation in standing.[51-53] The Upper Limb Hypermobility Assessment Tool is a validated tool that includes examination of shoulder, elbow, wrist, and finger passive physiologic motions, sulcus sign, elbow/radioulnar joint play, and hand length.[54] To implicate shoulder multi-directional instability, apprehension with or without laxity with the sulcus sign, and a minimum of 2 of the following: positive anterior or posterior drawer tests between 10° and 30°, and 80° and 100° shoulder abduction, and anterior or posterior apprehension tests is recommended.[55] An alternative 3-test cluster of apprehension, posterior apprehension, and hyperabduction has recently been proposed.[56]

A good starting place in the physical therapy examination for the hypermobile performing artist is an assessment of postures or movements that exacerbate pain or contribute to subluxations. Video can be useful for observation of complex artistic skills or activities that are difficult to reproduce in the clinic. Lack of proximal stability, faulty alignment, and impaired motor control are common movement impairments. For example, impaired lumbopelvic and hip dynamic stability can contribute to faulty alignment and excessive anterior glide of the femoral head with hip extension stretching and active hip flexion with battements (high kicks) in dance or piking/straddling (raising) legs for an aerialist. Similarly, excessive humeral anterior or inferior glide with inadequate scapular upward rotation may occur with overhead positions such as hanging in a circus artist. Hypermobile artists may also rely on passive stability at joint end ranges rather than using dynamic stabilizers to maintain more neutral joint positions in weight-bearing postures such as knee hyperextension of the support leg in a dancer standing on one leg or elbow hyperextension with hand-balancing.

Muscle weakness and proprioceptive deficits can accompany hypermobility[30,36,38,39] making it more difficult to stabilize hypermobile joints especially at the end ranges used in dance and circus. Muscle performance and motor control of lumbopelvic, hip and shoulder stabilizers are important to evaluate. Pelvic girdle stabilization with load transfer can be assessed with the Stork[57] and active straight leg raise tests (**Table 2**).[58] Reproduction of pain with active hip flexion with knee extended in supine that is relieved with passive posterior glide of the femoral head can implicate excessive anterior femoral glide.[59] Similar principles can be used to assess excessive humeral head translation including observation, palpation, and repositioning the humeral head with overhead movements.

Standardized functional tests can help quantify the severity of neuromuscular control deficits and identify compensatory movements. The forward step down test (**Table 2**) evaluates the ability of the hip abductors and deep hip lateral rotators to control femoral alignment in the frontal and transverse planes while descending a 20 cm step without allowing the leading limb to touch down.[60] The Star Excursion Balance Test is useful for evaluating lower extremity neuromuscular control especially in performing artists with a history of ankle instability.[40] The airplane, sauté and topple tests (**Table 2**) are useful dance specific movement assessments of lower extremity neuromuscular control.[61] For the upper extremity, the Closed Kinetic Chain Upper Extremity Stability Test (**Table 2**) is a valid functional test performed in a modified plank position that is highly correlated with maximum grip strength (r=0.78-0.79) and peak torque of shoulder internal and external rotators (0.87-0.94).[62]

Management

Successful management of symptomatic hypermobility in aesthetic artists is a lifelong process critical to career longevity that includes appropriate self-management in partnership with a supportive medical team. Physical therapists can be instrumental in patient education, strength, movement, proprioceptive and motor control training, in addition to collaboration with other health care and performing arts professionals.

Pain management education will differ depending on whether pain is primarily nociceptive, as with acute joint subluxation/dislocation, neurogenic, or centralized. Techniques to manage acute joint dislocations/subluxations recommended in a helpful Ehlers-Danlos Society patient resource[63] include mindfulness techniques for relaxation, redirecting focus or distraction, use of analgesics, supportive devices like pillows or slings, heat, and self-massage for reducing muscle spasm to encourage joint relocation.[63] Patients should seek medical attention after dislocation if a limb becomes numb or discolored due to blood flow occlusion, or if self-management techniques prove unsuccessful.[63] If subluxations/dislocations occur with specific postures or skills in their performing art, clinicians can collaborate with the patient and coaches to modify activities to minimize recurrence. Understanding that joint subluxation/dislocation in hypermo-

Table 1. Specific Patient History Considerations for the Aesthetic Performing Artist with Hypermobility

Artist identity and participation level	Is artist identity tied to hypermobility? How long have they been training in their art form? Is dance or circus a hobby, key component of fitness and mental health, career aspiration, primary income source, etc? Timeframe around upcoming auditions, performances or competitions? Flexibility to modify training load or participation during rehabilitation? Upcoming travel?
Mechanism of onset	Microtraumatic vs macrotraumatic event vs chronic widespread pain? Magnitude of forces to cause subluxations/dislocations and frequency? Nociceptive, neurogenic and/or central pain mechanisms?
Prior treatment	Past experiences with health care providers? Providers experience with performing artists/EDS? Effective/ineffective past interventions?
Self-management	Self-management strategies including medication, alcohol, marijuana usage? Usage and efficacy of supportive tools like braces, taping, pillows?
Habitual postures	Habitual postures in their activities of daily living and with participation in dance or circus (eg, Swayback posture or hyperextended knees with brushing teeth or excessive lumbar extension hanging from aerial apparatus)?
Fatigue	Frequency and severity? Effects on training, performance, socialization?
Sleep	Quality, duration and consistency? Effects on fatigue, mental health, and pain?
Nutrition	Disordered eating due to GI symptoms vs aesthetic demands of artistic role?
Menstrual history	Impacts of menstrual cycle on abdominal pain, joint laxity, motor control, and artistic performance?
Support systems	Are all their friends part of their artist community? Do peers, family, instructors, and/or artistic directors understand and take into consideration their medical condition or do they push them beyond what is safe for their bodies? Do they have adequate knowledge to support artist's health?
Other activities and participation	Away from dance/circus are they a student? Do they have another occupation/job? Are these active, sedentary, involve repetitive movements. or prolonged postures?
Performing arts participation	What are their dance styles and/or circus disciplines? Participation at a recreational, pre-professional or professional? Enrolled as student in intensive training program? Hours per week and intensity of training and performance? Do they participate in other fitness activities, cross training or strength training? How do they warm-up/cool down? Do they have specific exercises to work on strength through their range and motor control? Any periodization of training/usual rest periods? Any maintenance/conditioning during rest periods? Are they the most flexible person in their cohort? Can they do contortion movements or tricks that others cannot? Do they get casted for the "bendy" roles always perform choreography emphasizing flexibility? What is the culture of their training environment or company? Competitive vs. supportive; rigid vs. flexible; recreational vs. performance/competition focused; minimally vs. highly trained coaches?
Abbreviations: EDS, Ehlers-Danlos syndrome; GI, gastrointestinal	

bile individuals is less likely to cause tissue damage may help decrease associated fear or contribution to a centralized pain response. Acute nociceptive pain can also be triggered by gynecological and gastrointestinal dysfunction, potentially inhibiting lumbopelvic stabilizers. During these episodes, education is needed for activity modification due to diminished joint stability, followed by neuromuscular activation training for return to full participation.

Bracing can enhance proprioception and joint stability,[64] such as the use of an ankle support for dancers with recurrent ankle instability. Affordable bracing options for the shoulder, back, hip, knee, and ankle can be purchased through online retailers. In situations where a brace cannot be worn for performance, taping or lower profile compression garments may be helpful. It is helpful for menstruating patients to track their menstrual cycle and proactively brace problematic joints during pre-ovulation, because higher progesterone levels increase joint laxity.[65]

In patients with centralized pain presentations, pain neuroscience education (PNE) combined with exercise, including spinal stabilization and especially aerobic exercise, has been shown to decrease pain, fear-avoidance, pain catastrophization, and promote movement.[66-67] Both "Why Do I Hurt?"[68] and "Explain Pain"[69] are helpful resources to facilitate PNE. Patients with hEDS often have psychosocial risk factors such as pain catastrophization, kinesiophobia, and low pain self-efficacy.[30,32,33] Cognitive behavioral therapy (CBT) can also be an effective intervention to address chronic pain and

Table 2. Selected Physical Examination Measures

Test	Description	Scoring
Stork Test[57]	Patient stands with feet apart, examiner palpates S2 SP with 1 thumb and PSIS with other thumb on stance leg. Patient flexes opposite hip and knee to 90°.	**Positive test**, anterior rotation of innominate, cephalad movement of PSIS of stance leg, **Negative test**, innominate should posteriorly rotate relative to sacrum, PSIS moves caudad or no movement.
Active Straight Leg-Raise (to assess pelvic girdle load transfer)[58]	Patient is supine legs extended/20 cm apart, lifts straight leg 20 cm off table. Patient scores difficulty on 0-6. Repeat with manual compression at the pelvis.	**0-No difficulty, 1-Minimally difficult, 2-Somewhat difficult, 3-Fairly difficult, 4-Very difficult, 5-Unable** **Test is positive** for any score >0 that decreases with pelvic compression or pelvic compression relieves symptoms.
Active Straight Leg Raise (to assess anterior femoral glide syndrome)[59]	Patient is supine with legs extended, examiner palpates femoral head at inguinal crease, then cups ankle and passively flexes hip to 70° with knee extended. Next patient asked to actively hold their leg at that position as examiner releases hold on ankle.	**Positive test:** Examiner palpates femoral head glide anteriorly at inguinal crease when support released. **Negative test:** No movement of femoral head detected at inguinal crease (femoral head posterior glide and spin in acetabulum).
Forward Step-Down Test[6]	Patient stands on 20 cm step with hands on hips. With foot in maximal dorsiflexion, patient reaches heel to the ground below step without touching down 5 times on each leg.	***1 point each:*** 1. arm strategy to recover LOB, 2. trunk movement to recover LOB, 3. one side of the pelvis rotates in transverse plane, or elevates in frontal plane, 4. reaching foot touches down or stance limb foot moves, 5. if tibial tuberosity moved medially past second toe (1 points) past medial border of stance foot (2 points). Higher scores indicate impaired motor control and proximal hip muscle weakness.
Airplane Test[61]	Patient stands on one leg, then hinges forward so arms, trunk, pelvis and back leg are parallel to floor with arms at 90° abduction. They plié (bend) the standing leg while both fingertips reach towards the ground and return to start 5 times.	**Pass** is defined as completion of 4 out of 5 repetitions with neutral alignment of the lower extremities.
Single-Leg Sauté Test[61]	Patient stands on one leg, hands on hips, non-stance leg in coupé (touching stance leg at base of calf) leg. They perform 16 jumps.	**Pass is completing 8 out of 16 jumps with:** 1. Neutral pelvis; 2. Upright and stable trunk; 3. Knee extended in the air; 4. Pointed foot in the air; 5. No movement in the leg maintaining the coupé; and 6. Controlled landing in plie, rolling toe-ball-heel through the foot.
Topple Test[61]	Patient performs 3 pirouettes en dehors, turning on 1leg toward leg in passé (knee bent, toe placed at stance leg knee), starting from 4th position (stance limb in front, both legs externally rotated).	**Assess best turn each side with the following: (1 point each):** 1. In 4th starting position, pelvis squared, hips turned out, most weight on forefoot, and strong arms, 2. Lift to passé in one count; 3. Stance knee extended; 4. Torso rotates as a unit; 5. Strong, well-placed arms; 6. Quick spot; and 7. Controlled landing. Sum scores with higher scores indicating better motor control and strength.
Closed Kinetic Chain Upper Extremity Test[62]	Patient starts in plank with both hands on tape in push up position 36 in apart They alternate touching tape below opposite hand and returning to starting position for 15 sec.	Number of repetitions completed in 15 seconds is recorded. **Mean time** for healthy adults 13.31 ± 4.78 sec.

Abbreviations: cm, centimeters; in, inches, LOB, loss of balance; PSIS, posterior superior iliac spine; sec, seconds; SP, spinous process

kinesiophobia, including to enhance coping strategies.[70] The goal of this collaborative approach between therapist and patient is to decrease negative thoughts or feelings about the pain experience.[71] Cognitive behavioral therapy can be administered over the phone[71] or independently with utilization of workbooks. Physical therapists can also implement CBT-related strategies such as pain education, collaboration with the patient on a weekly walking goal, graded activity plan, using distraction techniques, replacing negative thoughts with positive ones, and identifying high risk situations that can cause setbacks.[71]

Individuals with hypermobility often need posture and movement retraining both to avoid overstretching passive structures at end range and improve dynamic stability and alignment throughout their range both with daily life activities as well as specific to performing arts participation. Hip pain related to hypermobility is common in dancers, gymnasts, and circus artists[72-73] and can be associated with faulty movement patterns like femoral adduction leading to microtrauma and ultimately hip pain.[59,74] Educating patients on correcting femoral adduction, strengthening hip flexors, deep hip lateral rotators, and hip extensors has been shown to decrease pain and improve function in patients with chronic hip pain.[74] Dance and circus movements emphasizing hip hyperextension and external rotation also contribute to increased hip laxity and excessive femoral anterior glide.[59,72] For this reason addressing swayback posture during standing and hip hyperextension through terminal stance with cues such as "push off more with your foot" can decrease the hip extension moment in gait[75] and stress on the anterior hip structures with daily activities.

In addition, aesthetic artists need education as to when and how to use their full range of motion (ROM) and when to use more mid-range positions for joint protection. Excessive reliance on hypermobile passive structures for sustaining prolonged postures or to stop a movement ("hanging on your joints") with lack of motor control in the mid-range can contribute to injury. Genu recurvatum with pes cavus is an advantageous aesthetic for some performers in audition and performance. These hypermobile performers should learn to use their full knee hyperextension range for non-weight-bearing movements as the gesture leg, and to keep knee extension closer to neutral when using the leg for support in weight-bearing. This concept can apply similarly for the elbows of a hand balancer in circus. Artists relying on passive stability with weight-bearing activities may need significant proprioceptive and muscle endurance training to sustain more neutral positions. In addition, as hypermobile artists move through extremes of ROM, it is important to ensure they have strength and good control through the entire range and are not relying solely on momentum and passive structures to achieve end range movements.

Performing artists need to do additional strength and proprioceptive training to improve joint stability due to lack of passive support. Resistance training is thought to improve musculotendinous stiffness that contributes to passive stability[76] and can decrease shoulder rotation hypermobility.[77] Individuals with hEDS/HSD typically present with increased weakness compared to controls, taking 3 to 4 months longer to make strength gains.[78] Despite some question as to whether inefficient force transfer due to increased musculotendinous extensibility limits the trainability of muscle strength in hEDS,[79] these individuals have been found to make strength gains at the same rate as people with asymptomatic hypermobility, and without hypermobility.[78] Improvements in strength correlated with statistically significant decrease in pain, and improvement in function.[78] It is important for artists as well as their support network (family, coaches, etc) to understand that although they may make similar strength gains, injured hypermobile artists often need a longer course of rehabilitation and graded return to activity due to baseline weakness, need for joint protection and the multi-system effects of hEDS/HSD.[78]

Participation in strength combined with balance training can improve pain, physical function, and proprioception in the hypermobile population.[80-82] While muscle weakness is the primary factor associated with activity limitations, muscle weakness and proprioceptive deficits often exist together,[79] which supports the need to focus on motor control training in addition to muscle force production. Addressing correct muscle activation patterns without compensation including coactivation of spinal stabilizers when performing limb movements is critical from foundational to advanced performing arts technique. Exercises that combine strength and proprioception also decrease the risk for overtraining and fatigue.

Fatigue should be addressed due to the prevalence in hEDS/HSD and as an intrinsic risk factor for injury in dance.[30,40] Preventative measures include pacing to conserve energy during performance or heavy rehearsal periods, using a modified exercise program with lower demand and adequate joint protection strategies with an emphasis on correct muscle activation during symptomatic flares, altering a training schedule to allow for adequate rest, modification of practice (such as mental practice) as well as the use of cross training during recovery periods to stave off deconditioning. Professional performing artists often have a full schedule, but it may not provide the needed cross training for strength and cardiovascular capacity needed to mitigate fatigue. Twitchett et al[83] suggest replacing 2-3 of the typical 5 dance technique classes per week with physical conditioning classes to prevent overtraining without the loss of technique/skill. These strategies can help hypermobile performing artists manage fatigue and joint stresses, hopefully contributing to longevity and performance in their art.

Adolescent dancers and circus artists often stop participation once diagnosed with hEDS. Unfortunately, this may inadvertently lead to deconditioning often resulting in the worsening of symptoms, including fatigue, and an increase in fear-avoidance behavior. Relative rest and activity modification should be recommended rather than complete cessation of performing arts activities. Adolescents with hypermobility who participated in a formal dance program were shown to have less pain, joint instability, fatigue, and higher health related quality of life.[84] Early education, on managing hypermobility in the context of the performing arts, should be emphasized to enhance their strength and well-being.

Education and collaboration with performing arts professionals is another important part of management. It is important for performers to understand where a healthy challenge ends and increased injury risk begins. Studio environments can vary from competitive to collaborative, so clear communication with the directors and staff about the specific needs of the hypermobile performer is important to facilitate artistic growth. Physical therapists can be an advocate to validate and explain the performer's experience to family, friends, or performing arts professionals who may not understand or believe the performer.

CONCLUSION

Hypermobility disorders such as hEDS/HSD are more prevalent in performing artists including dancers and circus artists but are often overlooked or improperly managed. Physical therapists can help to screen for multi-system involvement in patients with hypermobility and facilitate referrals for earlier diagnosis and improved collaborative interprofessional management. Hypermobile aesthetic artists also need additional assessment and unique management strategies to optimize their participation and performance.

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Appendix. Hypermobility Screening Tool

Hypermobility can sometimes occur with other health problems that may not seem related. To help your provider screen for these, please ***check off the symptoms that you have experienced in the past 6 months*** and then ***circle the top three symptoms that most affect your life***.

Section A: I had pain…
- ☐ in one area
- ☐ in a few areas
- ☐ all over my body
- ☐ with light touch
- ☐ when I even think about moving
- ☐ with sex
- ☐ in my pelvis that is worse with standing, but better with lying down
- ☐ in my stomach/abdomen

Section B: I experienced…
- ☐ severe fatigue
- ☐ unrefreshing sleep
- ☐ difficulty sleeping or staying asleep
- ☐ sleep apnea (interrupted breathing)
- ☐ brain fog/ forgetfulness
- ☐ fatigue all the time that limits my ability to do daily activities
- ☐ heat or cold intolerance

Section C: Sometimes/often I…
- ☐ felt like I was going to faint
- ☐ fainted (lost consciousness)
- ☐ had difficulty remembering things
- ☐ had difficulty processing information
- ☐ had a racing or pounding heart
- ☐ had headaches/migraines
- ☐ had low blood pressure
- ☐ had heart palpitations
- ☐ had difficulty concentrating
- ☐ felt faint, dizzy or had vision go black when sitting or standing or standing up

Section D: My skin…
- ☐ was soft/silky/velvety
- ☐ was thin, I can see my veins easily
- ☐ was mildly stretchy
- ☐ was very stretchy
- ☐ was fragile
- ☐ took a long time to heal
- ☐ healed with flattened or widened scars
- ☐ had stretch marks from growing
- ☐ bruised easily

Section E: I felt…
- ☐ anxious
- ☐ depressed
- ☐ panicked at times
- ☐ low in self confidence
- ☐ negative about things
- ☐ hopeless
- ☐ desperate
- ☐ afraid of doing certain things
- ☐ resentful of healthcare providers
- ☐ distrustful of healthcare providers
- ☐ scared or worried about physical movement

Section F: Sometimes I had:
- ☐ flushing (skin turning red)
- ☐ hives (red bumps on skin)
- ☐ itching
- ☐ allergic reactions
- ☐ sensitivity to foods, chemicals, medicines, or the environment

Section G: I often had…
- ☐ constipation
- ☐ diarrhea
- ☐ abdominal bloating
- ☐ abdominal cramping
- ☐ heartburn
- ☐ recurring abdominal pain

Section H:
- ☐ I had difficulty getting numb during dental procedures
- ☐ My teeth moved quickly with braces/ moved back quickly after braces
- ☐ I have been told my teeth had higher cusps and deeper fissures
- ☐ I had jaw issues/difficulty keeping my mouth open during dental procedures

Section I: In my childhood, I experienced…
- ☐ clumsiness
- ☐ stomach problems
- ☐ difficulty with toilet training, bedwetting
- ☐ sprained ankles
- ☐ being double jointed
- ☐ emotional difficulties
- ☐ learning difficulties
- ☐ writing difficulties

Hypermobility can sometimes be connected to other health problems that have been diagnosed by a doctor or specialist. Please let us know if you have ever been diagnosed with any health problems below by ***checking the associated box***. Also, if anyone in your family has been diagnosed with any health problems below, please **underline**.

Gastrointestinal

- ☐ Irritable bowel syndrome (IBS)
- ☐ Functional gastrointestinal disorder
- ☐ Gastroesophageal Reflux Disease (GERD)
- ☐ Dysphagia
- ☐ Rectal evacuatory disorder
- ☐ Eosinophilic esophagitis

Cardiovascular

- ☐ Postural Orthostatic Tachycardia Syndrome (POTS)
- ☐ Syncope
- ☐ Aneurysm
- ☐ Neurally mediated hypotension
- ☐ Mild aortic root dilation
- ☐ Mitral valve prolapse
- ☐ Dysautonomia

Musculoskeletal/ Connective Tissue

- ☐ Temporomandibular (TMJ) issues
- ☐ Upper cervical instability
- ☐ Joint subluxations/ dislocations
- ☐ Scoliosis
- ☐ Low back pain
- ☐ Degenerative joint disease/ osteoarthritis
- ☐ Periodontitis
- ☐ Hernias
- ☐ Prolapses
- ☐ Any sort of organ rupture (i.e. spontaneous pneumothorax)
- ☐ Chronic regional pain syndrome (CRPS)

Neurological/ Neurodevelopmental

- ☐ Small Fiber Neuropathy
- ☐ Headaches
- ☐ Chiari-like headaches and/or Chiari malformation
- ☐ Migraines
- ☐ Headaches with ear symptoms
- ☐ Headaches with tinnitus
- ☐ Headaches with ear fullness
- ☐ Tethered cord syndrome
- ☐ Tarlov cyst
- ☐ Attention-Deficit Hyperactivity Disorders (ADHD)
- ☐ Autism or Autism Spectrum Disorders
- ☐ Developmental coordination disorder

Immunological

- ☐ Asthma
- ☐ Allergies or sensitivities – food
- ☐ Allergies or sensitivities - medication
- ☐ Allergies or sensitivities - environmental
- ☐ Celiac disease
- ☐ Mast Cell Activation Syndrome (MCAS)
- ☐ Autoimmune disorder

Genitourinary/Pelvic

- ☐ Menorrhagia (heavy menstrual bleeding)
- ☐ Endometriosis
- ☐ Pelvic floor disorders, including pain
- ☐ Pelvic organ prolapse
- ☐ Incontinence and/or urinary retention
- ☐ Sensory abnormalities

Psychological/ Behavioral/ Fatigue

- ☐ Anxiety
- ☐ Depression
- ☐ Panic disorder
- ☐ Affective disorder (depression, bipolar, etc.)
- ☐ Eating disorder (anorexia, bulimia)
- ☐ Chronic Fatigue Syndrome
- ☐ Fibromyalgia
- ☐ Insomnia
- ☐ Restless leg syndrome
- ☐ Sleep apnea

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Clinician Guideline for the Hypermobility Screening Tool (HST)

For the Symptom checklist (Page 1):

- Sections A-H identify recent issues; Section I is historical to lend perspective on chronicity
- Note the number of symptoms and sections with checks for a better understanding of the number of body systems affected and extent. If the patient has symptoms but not a formal diagnosis, this may indicate the need for a referral (see table below).
- Use the three symptoms circled to prioritize a discussion about the extent of the effects on their life, physical therapy management, and outside referrals, particularly if they are negative prognostic indicators for physical therapy.

For the Diagnoses checklist (Page 2):

- Again note the number of diagnoses and sections with checks for an understanding of multisystem involvement.
- Use the checked diagnoses here and symptoms page 1 to guide a discussion of patient's understanding of health problems and how the health problems are being managed (unmanaged vs. self-managed vs. by an appropriate provider)

Using the HST to initiate or enhance interprofessional communication and collaboration with the other providers (see table below) that are actively managing or could manage related diagnoses is strongly encouraged. With patient consent, sharing information gained from physical therapy evaluation and management may assist other providers in differential diagnosis and management decisions. Information about exercise tolerance, psychological considerations and other provider perspectives can also enhance our care as physical therapists. This team approach will optimize outcomes for patients with hypermobility.

RECOMMENDED PROVIDERS	RELATED HST FINDINGS AND/OR ROLE IN CARE
Genetics	Diagnosis of hEDS/HSD, to rule out other molecular diagnoses
Gastroenterology	Gastrointestinal symptoms **(Page 1: Sections A, B, G)**
Cardiology	Dysautonomia (i.e. POTS) **(Page 1: Sections B and C)**
Pain management	Centralized pain presentation **(Page 1 Sections A and B)** and diagnostic injections
Neurology (autonomic or behavioral subspecialty)	Dysautonomia, neuropathies, headaches, autism/autism spectrum disorders **(Page 1: Section C)**
Plastic surgery	Scar management **(Page 1: Section D)**
Psychiatry, psychology, mental health	Coping strategies for chronic pain and fear of movement, Cognitive Behavioral Therapy, psychotherapy, medication **(Page 1: Section E)**
Immunology/Allergy	MCAS management, sensitivities and allergies **(Page 1: Section F)**
Nutrition	Disordered eating/food intolerance **(Page 1: Section F and G)**
Dentistry	Management of fragility involving oral mucosa **(Page 1: Section H)**
Obstetrics/gynecology/ urogynecology	Pregnancy, endometriosis, hormone related symptoms and pelvic floor issues including hernias/prolapses, pregnancy
Occupational therapy	Writing difficulties, fine motor skill difficulties, ring splints
Social work	Social support and advocacy
Orthopedics/Rheumatology	Musculoskeletal/connective tissue issues
Podiatry	Foot/ankle issues, support devices for flexible foot
Sleep specialist	Insomnia, sleep apnea, restless leg syndrome

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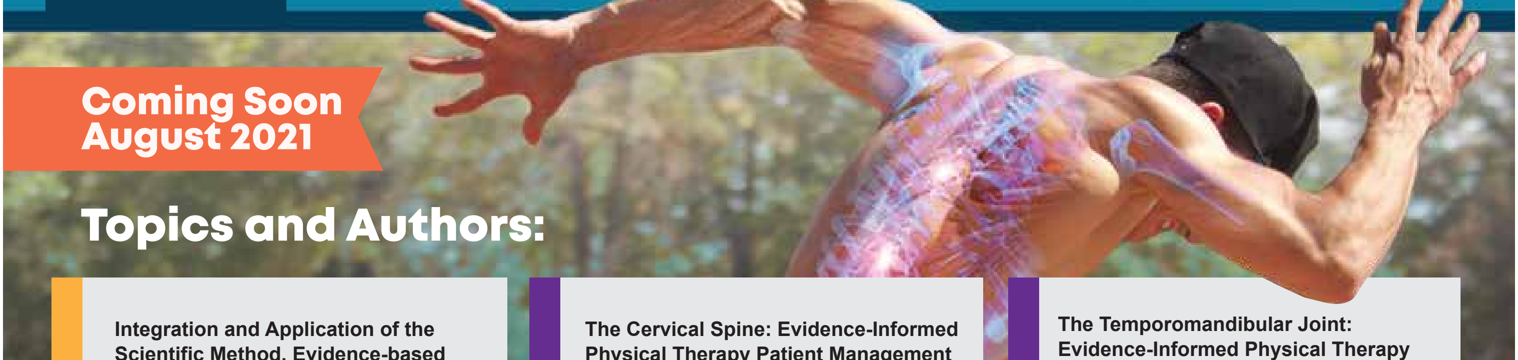

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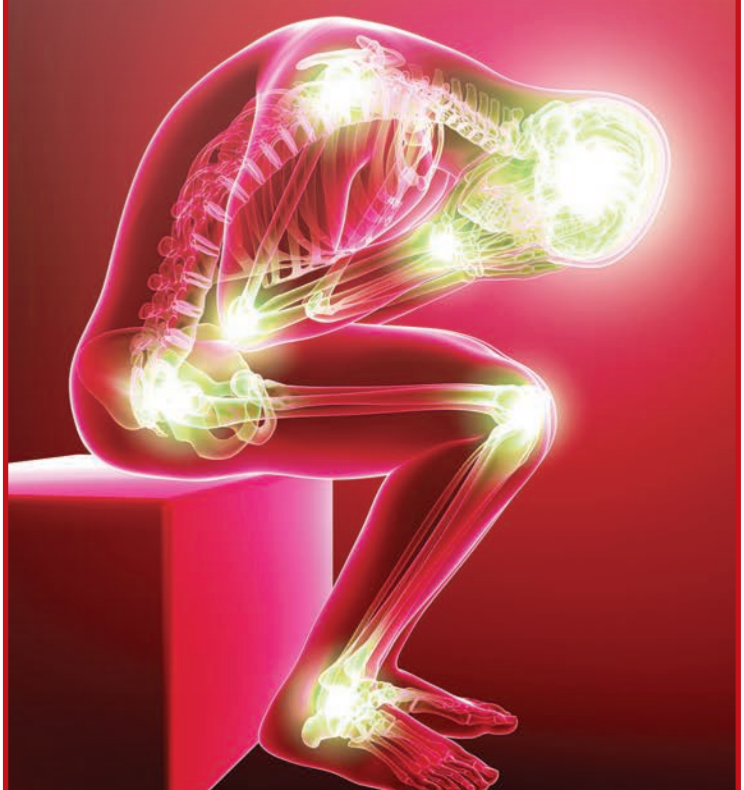

Low Back Pain in Circus Artists: Using a Movement System Impairment Framework as a Component of Care

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ABSTRACT

Background and Purpose: Performing artists-athletes that use extreme ranges of spinal motion are at higher risk of low back pain (LBP) than other athletes. Among all injuries in circus artists, 16-35% occur at the spine. The purpose of this article is to demonstrate common faulty lumbar movement patterns in circus artists and how pattern recognition, as with the movement system impairment (MSI) classification, can enhance care of these athlete artists with LBP and give clinicians a communication tool to discuss movement, load, and pain abatement. **Methods:** This article summarizes the clinical experience of treating LBP of one physical therapist with 30 years of working in circus arts and 12 years as a clinician. **Clinical Relevance:** Use of the MSI system can help clinicians recognize common faulty patterns in a circus artist's movement and aid the performers understanding of how to modify their training. **Conclusion:** Circus artists have high demands on their bodies and are heavily invested in their care. Use of the MSI system further improves communication between the clinician and performer, thus enhancing the rehabilitation of lumbar injuries.

Key Words: acrobat, aerialist, athletic injuries, lumbar, performing artist

BACKGROUND

Recreational circus arts participation in the United States has grown exponentially in the last decade from a few to over 256 schools registered with the American Circus Educators association (ACE) in 2019.[1] Still more schools exist that are not registered with any organization.[1] Of the schools that have responded to ACE surveys, over 50% have opened in the last 10 years and a third in the last 5.[2] Circus, aerial yoga, acro-yoga, and aerial schools are cropping up all over the country in cities and small towns. Though one may think of circus artists as unique stars under the lights, recreational circus artists are just as likely to be our co-workers down the hall who train for fitness, community, and fun after work or your neighbor's children who are participating in circus as their physical education in school or at a youth performance company. Circus arts are a fantastic recreational activity that improve body image and physical literacy.[3,4]

Injuries in circus artists affect not just their bodies, but also their training, sense of identity, career, and community.[5] Therefore, it is important for clinicians to recognize these performing artists as athletes and to help them get back to training as soon as possible. The prevalence of spinal injuries in circus artists is reported to range between 16% and 35% of all injuries.[6] Repeated movements at their end range of motion, coupled with loading, may make circus artists more susceptible to low back pain (LBP).[7] Performing artist-athletes such as dancers, figure skaters, and gymnasts, similarly use extreme ranges of spinal motion and repeated movements to achieve their specific skills. These artists are at higher risk of LBP than other athletes.[8]

As the population of circus artists of all levels continues to grow, clinicians become more and more likely to have one of these artist-athletes walking through the clinic doors, especially those at the recreational level. In looking at gymnasts at the elite and sub-elite levels, the sub-elite athletes are noted to have higher injury rates.[9,10] As recreational circus arts continue to grow in the United States, one may also see a higher incidence of injury.

Though not every clinician knows the language and vocabulary of circus arts, pattern recognition can help provide clinicians a framework to work with and a way to educate their patients.[5] The purpose of this article is to demonstrate common faulty lumbar movement patterns in circus artists and how pattern recognition, as with the movement system impairment (MSI) classification, can enhance care of these athlete artists with LBP and give clinicians a communication tool to discuss movement, load, and pain abatement.

MOVEMENT DEMANDS OF CIRCUS SKILLS

Circus training requires a high level of precision movement to execute skills safely and properly. In circus, as in dance, skating, or gymnastics, there is a relatively large vocabulary of movement based on fundamental body positions. Many of the essential skills, such as hanging, handstands, or a split (**Table 1**), require both end-range mobility and strength so the artist can safely move from one skill to the next.

The artist often moves into and between end range motions of the extremities and/or spine imposing dynamic forces that need to be safely transferred through the body with control. These motions include repeated hyperextension of the lumbar spine. Aerial circus artists move through their spinal motion to generate power while hanging from their hands by swinging their body in a "beat" or to flip and rotate or in contortion to allow an artist to bend to their extremes. This repeated lumbar hyperextension has been shown to increase the risk of LBP and pars defects.[11] Circus artists may also need to fully flex their spines under compressive loads when trying to spring out of a position, as needed for partner trapeze work as they move through a basket position (**Table 1**). The repeated flexion under load may place them at risk for discogenic pain.[12]

In addition to the direct demands on circus artists' spines, artists are also adding to that load with the large range of extremity motion. For example, as hanging artists lift their legs overhead to invert, the long lever of their legs exerts a load on the spine increasing the forces the artist must control. This is why extremity motion can increase LBP symptoms.[13] Due to the complex nature of circus movements, it is important to assess the effect of unilateral and bilateral extremity motion in the directions most relevant to the artist's discipline.

As circus artists learn movements and skills that push their limits of strength, neuromuscular control, technique, and abilities, they are more likely to reach the threshold of their endurance and trunk stability. In a fatigued state, their trunk control is decreased and they are at risk to develop compensation patterns that might lead to an increased risk of LBP and injury.[14] The extraneous movement makes their skills more difficult and can decrease performance capacity.

Table 1. Common Circus Symptomatic Movements by MSI Lumbar Diagnosis

Lumbar MSI Diagnosis	Circus Movement	Compensation	Movement Example
Extension	**Hanging Leg Lift** While hanging from an apparatus the artist lifts their legs to turn upside down	Lumbar extension moment with active hip flexion against gravity	
	Handstand The artist is inverted and standing on their hands	Lumbar extension with shoulders not in full flexion or hips not in full extension	
	Bridge The artist has their hands and feet on the ground and pressed their body up into an arch	Hips not in full extension or shoulders not able to achieve full flexion often with excessive extension or "hinging" at the lumbar spine	
Rotation	**Front Split** The artist has one leg straight in front of them and one to the back	Hips are not "square" with excessive lumbopelvic rotation. - Possibly rotation with extension depending on other symptomatic positions	
	Hip Key Contralateral leg movements with one leg moving into flexion and then abduction as the trailing leg moves into extension then abduction creating a circular pathway	Increased lumbopelvic motion with decreased hip active range of motion - Possibly rotation with flexion depending on other symptomatic positions and when it is painful during the movement	
	Hanging/Handstand Full shoulder flexion either inverted on hands or hanging from hands with an engaged trunk and core	If there are unilateral shoulder range of motion deficits there can be a rotation of the spine relative to the pelvis	
Flexion	**Basket/Pike Hang** Hanging in an inverted pike position from the artist's hands on an aerial apparatus or partner	Legs are not parallel to the ground and there is increased unsupported spinal flexion	
	Pitching and Catching The base/porter squats to lift, throw, and soften the catch of another acrobat	Decreased hip mobility and increased lumbar flexion especially during the pitch and then catching phase	

USING MSI DIAGNOSES IN THE CARE OF CIRCUS ARTISTS

In circus disciplines, the artists often repeat the same movements and skills as they build on basic vocabulary to complete complex routines. These repeated spinal motions may become movement patterns that are so well trained and repeated that they become apparent during their physical therapy evaluation when using a movement examination. Though the artist may not be symptomatic with standard movement testing, often the same impaired patterns of movement are exhibited. Being able to recognize these patterns can help the clinician use the tools available to them to provide a framework for a patient's care without their apparatus present. If a patient has pain with inverting when hanging, but there is not a way to have them hang in the clinic, the therapist may be able to identify a pattern of lumbar extension when performing bilateral leg lowering in supine. Or, the therapist might find that when the artist moves into full shoulder flexion, as needed in hanging, the artist exhibits the same lumbar extension.

Even clinicians new to the MSI approach have been able to reliably classify patients into the same category with a high degree of intertester reliability.[15,16] Giving these artists a movement diagnosis provides the clinician a tool to personalize the care and recognizing these patterns of symptom provocation provide the patient and the clinician a shared language to communicate about movement.[17] They can then more readily discuss and collaborate with the artist and/or coach on how to modify training load or skills, as necessary, to decrease their symptoms as they heal without requiring them to stop training completely. In the general population with LBP, educating patients on changing how they perform common everyday movements had a higher adherence rate than exercise-based therapy.[18] In the circus performing artists, educating the artists about their movement diagnosis and compensation patterns in their daily training will help to make movement pattern changes that are important to their art form and training. These corrections in turn will become their exercises for rehabilitation.

In the MSI framework there are 5 diagnostic categories: flexion, extension, rotation, and the combination of rotation with flexion and rotation with extension. The diagnosis is based on the patient's tendency to move the spine into that specific direction during movement of the extremities or spine.[13,19] For example, the spine moves into extension both as the artist raises their arms overhead or flexes their hip. This tendency of directional spinal motion coupled with LBP symptoms from extremity movements make up the patient's diagnosis.[13,19]

Movement system impairment diagnoses are based on a standardized examination during which the clinician observes how the patient moves while monitoring for signs and symptoms.[19] The clinician can then correct the patient's movement with either verbal or tactile cues to evaluate whether their symptoms change. By administering the evaluation, the clinician can get a strong idea of what patterns appear repeatedly and which are correlated with the patient's symptoms.

Once the clinician has established the MSI diagnosis, the clinician will be able to use it to direct individualized care and treatment of the circus artist with more specificity. It benefits the clinician to then observe the patient's circus skills live, through video, or photos to identify where and when those repeated patterns may be occurring and are detrimental to their efficiency of movement. Excessive spinal motion can increase the difficulty of circus skills and can put the artist at risk of injury or pain.[20]

CONCLUSION

Circus artists have high demands on their body that are specific to their discipline and apparatus. Physical therapists understand how bodies work, but we may not have the skill specific vocabulary to cover all the skills and load demands of circus artist athletes. An MSI diagnosis provides clinicians a tool to communicate with these artist-athletes that bridges that gap.

Circus artists do not want to stop training.[7] Using the MSI framework can help them understand where to look in their movement pathways when they encounter symptoms. This can help the athlete to control which skills to modify or where to focus on their technique so they can continue to do what is so integral to their lives. By making training part of their treatment plan, they are working towards their functional goals from day one and can decrease the fear they may have when returning to higher level skills. Keeping these artists engaged in their training and circus community helps keep them mentally and physically stronger so it will be easier for them to return to their full training load.

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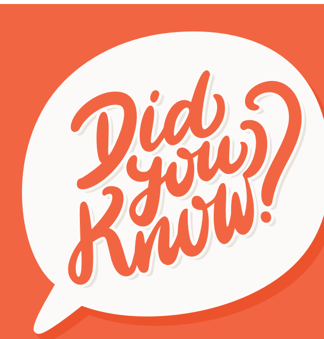

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Management of Transitional Vertebra in An Amateur Level Teenage Circus Acrobat: A Case Report

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ABSTRACT

Background and Purpose: Low back pain is a commonly encountered condition affecting youth athletes and in circus performers. This case report describes the treatment of an amateur circus acrobat with a transitional vertebra and a spondylolisthesis. **Case Description:** A 15-year-old amateur level circus acrobat presenting with 4 years of chronic low back pain. Imaging confirmed a diagnosis of Bertolotti's syndrome, or transitional vertebra; physical therapy examination revealed segmental hypomobility, decreased motor control, and neural tension. **Outcomes:** Over the course of 16 physical therapy visits and collaborating with the acrobatic coach modifying the patient activity level, the patient reported significant symptoms reduction. The constant low pain and intermittent left lower extremity numbness disappeared, and the intermittent left lower extremity pain decreased from 7/10 to 3/10. The patient returned to participation in acrobatic shows. **Clinical Relevance:** This case exemplified the importance of collaboration between traditional physical therapy and acrobatic coaching. Effectively combining the two allowed achievements of acrobatic and performance goals while simultaneously addressing motor control, neural tension, and segmental hypomobility. **Conclusion:** The treatment of circus acrobats requires consideration for additional details including in-depth biomechanical assessment and task modification when necessary as well as collaboration with coaches to provide maximal physical therapy results.

Key Words: Bertolotti's syndrome, hoop diving, pediatric low back pain, pike

INTRODUCTION

Low back pain in pediatric athletes has been reported in 20-30% of the population[1] and spine injuries rank second in incidence behind lower extremity injuries (most reported as ankle injuries[2-4]) in the circus arts. The high amount of stress placed on the spine during jumping, landing, repetitive twisting, bending, and extending[5] may account for the incidence of spine injuries reported at 14% of all injuries noted in Munro's observational study of one Australian circus school.[2] Moreover, Wanke et al noted more acute low back injuries when comparing acrobats performing floor routines to those performing with equipment or props (eg, trapeze, tightrope).[4] Due to the unique sport demands, physical therapists must be creative when assessing and treating these patients, using a different approach for successful return to performance. The presence of a relatively hypomobile segment or soft tissue with decreased flexibility may lead to aberrant movement mechanics or force production, which may place the acrobat at a higher risk of injury. This case report describes the treatment of an amateur circus acrobat with a transitional vertebra and a spondylolisthesis.

CASE DESCRIPTION

Case Characteristics

The patient, a 15-year-old female, presented to outpatient physical therapy with complaints of chronic low back pain for the previous 4 years; the patient remembers falling on her back during a competition, but has no recollection of a clear injury. At the time, the patient was involved in Junior Olympic gymnastics and continued to train with back pain. The patient recalled instances when coaches used painful overpressure into lumbar flexion during seated hamstring stretching to obtain increased range. The patient transitioned from gymnastics to acrobatics the year after her pain started and since that time has specialized in hoop diving, training at a circus center roughly 10 to 12 hours per week. In hoop diving, acrobats repeatedly travel across the floor at speed and flip, dive, or leap through hoops of varying size, height, and arrangement (**Figure 1**).

At examination, the patient's chief complaint was pain spanning across the low back described as a constant 1/10 ache. Secondary complaint was intermittent 7/10 sharp pain radiating down the left lateral posterior thigh along with light lower leg numbness during forward bending. The patient reported having pain with certain positions in hoop diving (pike/tuck) but did not modify her trainings other than by limiting the number of repetitions when her back hurt (**Figure 2**). Self-massage and "cracking her back" would decrease pain intensity. Of note, the patient reported concurrent bilateral wrist and left ankle pain that was not evaluated at this time. The patient reported no night pain, weight loss or gain, fatigue, fevers, or changes in bowel in her screening questionnaire and no abnormal pathology was noted in her current or past medical history.

Due to multiple sites of pain (chronic low back, wrist, and ankle pain), the patient initially sought care from a pediatric sports medicine doctor and was diagnosed with mechanical low back pain and a suspicion for general hypermobility. The patient was then referred to physical therapy for management. Imaging, both radiograph and magnetic resonance imaging reports, revealed 3 mm of retrolisthesis of L4 on L5 and lumbosacral segmental abnormality with broad transverse processes of L5 articulating with the sacrum, otherwise known as a transitional vertebra (L5 on S1), or Bertolotti's syndrome.

Tests and Measures

On examination the patient presented with increased thoracic kyphosis sitting, impaired functional mobility during single leg squat (Trendelenburg, medial longitudinal arch collapse, trunk flexion, and genu valgum), gait deviations (limited thoracic spine rotation with increased pelvic rotation and hard heel strike with bilateral foot eversion during mid stance and terminal stance) were observed (**Table 1**). Bilateral hip passive range of motion into flexion range was 105°, internal rotation hip flexed 10°. Lumbar spine composite range of motion for flexion (measured via tape measure from her fingertips to the floor) was 3 inches without loss of lumbar lordosis, lumbar extension was 60° and bilateral side bending 30° (both measured using inclinometer).

The patient reported increased pain locally in her low back with sacral and L5 posterior-to-anterior (PA) grade III mobilizations and improved with PAs at L1-4. Four of six of the Laslett sacroiliac joint (SIJ) provocation test cluster (Gaenslan bilaterally, distraction and sacral thrust[7]) were positive.

Figure 1. Hoop Diving

Figure 2. Pike Position (left), Tuck Position (right)

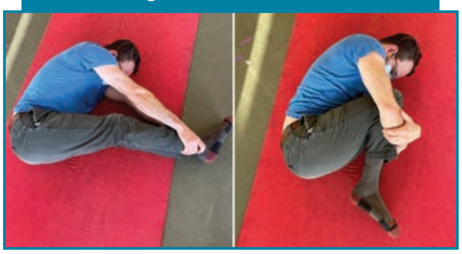


Table 1. Physical Examination Findings for the Patient in This Case Report

Range of Motion	Lumbar: Flexion = 3 inches from the floor Extension = 60° Sidebend = 30° bilateral Hip: Passive ROM Flexion = 105° bilateral Internal Rotation (@90°) = 10° bilateral
Neurodynamic Mobility	SLR: R = 95° L = 85° with symptoms
Tissue Mobility	Soleus flexibility: knee to wall* (cm): R= 6.5, L = 6 *Measured from wall to end of great toe
Strength	Hip Extension: B = 4+/5 Hip Abduction: B = 4/5 Hip Internal Rotation: R = 4/5, L = 4+/5 Hip External Rotation: B = 4/5 Poor stamina with planking and side planking
Functional Mobility	Seated posture = significant thoracic kyphosis Gait = stiff thoracic spine with increased pelvic rotation and hard heel strike, bilateral foot eversion during mid stance and terminal stance Single Leg Squat = Trendelenburg, pronation, trunk flexion, genu valgum Difficulty disassociating between hip extension and lumbar extension
Palpation/Joint Mobility	Sacral PA = + for symptom reproduction L1-L4 PA = alleviating L5 PA = + for symptom reproduction
Special Tests	Laslett Cluster = + for Gaenslan bilaterally, distraction, sacral thrust - for thigh thrust, compression

Abbreviations: L, left; PA, posterior-to-anterior pressure; R, right; ROM, range of motion; SLR, straight leg raise

The patient had decreased hip extension, abduction, external rotation, and internal rotation strength bilaterally with manual muscle testing and difficulty disassociating between hip extension and lumbar extension. She displayed poor stamina with forward and side plank with inability to hold position for more than 30 seconds without increasing lumbar lordosis.

On the passive left straight leg raise (SLR) at 85°, her low back symptoms increased and posterior thigh pain and tingling into the foot were also elicited if the position was maintained. The right SLR was 95° without symptoms. Both were performed with her ankle fully dorsiflexed. while her right SLR could be taken into adduction and internal rotation symptom free.

Lastly, when she demonstrated her static supine pike and tuck positions (**Figure 2**), all of her trunk flexion was taken above T10 without losing her lumbar lordosis. The angle of hip flexion for those two positions was also limited to 100°.

Clinical Reasoning

Prevalence of a transitional vertebra range is between 4% and 30% of the general population[6] and although the patient's presentation initially suggested possible SIJ dysfunction due to positive Laslett cluster, the patient demonstrated a negative thigh thrust, which is the most sensitive of the testing cluster.[7] In addition, her symptoms elicited by testing did not align with Laslett's description of familiar pain,[7] more simply stated as symptomatic pain.

The positive Laslett cluster tests are more indicative of findings of localized lumbar hypermobility, which are not uncommon in the presence of a transitional vertebra[6] combined with spondylolisthesis.[8] Due to the sacralization of the last lumbar vertebrae, the segment above, in this case spinal level L4, move a greater amount to compensate for the lack of movement that is occurring due to sacralization of L5.[9] These segmental differences could be detrimental for acrobats due to the repetitive lumbar strain from bending, arching, twisting, jumping, and landing.[10] In this case, lumbar flexion of the lumbar spine caused a shearing force at the level of patient's retrolisthesis, provoking her symptoms. Combining the lack of hip flexion and motion like pike and tuck in a dynamic fashion were causing more torque in flexion to the spine, increasing the shearing effect. The translation of the vertebra from the spondylolisthesis at L4-5 was causing the neural tissue to be compressed at that level and explains the lack of range of motion and symptoms provocation with her SLR.

On initial examination, the range of possible pain-free movements were mutually incompatible with the patient's performance demands. Consequently, the treatment plan needed to account for the patient's unique athletic demands while simultaneously limiting pain provoking positions, addressing relative joint and soft tissue restrictions, and educating the patient and acrobatic coach regarding correct form with all functional mobility (ie, single leg squat form).

Treatment

Treatment first focused on addressing right-sided gluteal weakness and core stabilization. Initially, the patient's total weekly training time was ≤ 20 hours a week in preparation for a show. Considering her total workload, the prescription of exercises focused on one or two exercises at a time during both treatment sessions and her home exercise program (**Table 2**).

Along with exercises, treatment sessions included manual therapy to address the hypomobile regions of her lumbar spine above L4-5, lower thoracic spine, and hips. The mobilizations used were PAs from L1-4 and bilateral rotation to T9-10-11-12 (**Table 2**). The neural tension techniques, termed "sliders" and "tensioners" were combined with lumbar and thoracic mobilizations for increased effectiveness[11,12] (**Figure 3A, 3B**). Mobilization to address the lack of hip flexion were attempted, but no changes were observed during or between sessions and therefore stopped after 3 visits. In addition, the physical therapist used myofascial decompression[13] soft tissue technique for the patient's spinal extensors, calf tissue restrictions, and posterior back line[14,15] (**Figure 3C, 3D**). This technique uses cups or negative pressure to affect the glide of the epimysium and neural tissue for improved movement.[16] After addressing the lack of mobility of the upper lumbar spine, the paravertebral musculature, and the neural tissues (nerve roots and sciatic nerve) with different manual therapy approaches separately and combined, the patient was able to move through the end of range flexion (spine and hips combined) without pain.

Following the 7th visit, in an effort to prevent future flare-ups, with the patient's permission, lines of communication were opened with her acrobatic coach. A partnership was developed by including the coach in the treatment process. The coach was educated on the pathology and problematic movements, specifically lumbar flexion combined with hip flexion, which led to proactive identification and modification of potential high risk acrobatic movements during training.

The shared knowledge approach between coach and physical therapist followed a framework. The physical therapist identified specific movements capable of provoking a flare-up or reinjury. The coach and physical therapist collaborated to share an understanding of said movements. The coach was empowered to identify and address said movements as they arose during acrobatic training.

The acrobatic coach contributed to the partnership by modifying training to improve her technique and prevent further injury. Added training exercises for improved tumbling addressed spine stability during dynamic transitions, specifically, maintaining correct form during roundoff rebound to prevent aggravation of retrolisthesis. While the roundoff rebound is a common tumbling moment for form breaks, the anatomical variation in this case significantly narrowed the acceptable margin of error and subsequently required extra focus on form.

The warm-up routine was also individualized. Elements of lumbar flexion combined with hip flexion were removed or modified. For example, the pike position of the routine

Table 2. Interventional Classification Used During Treatment Sessions

Session Number	Manual	Ther Ex	NMR	Sport specific activities
1	MFD spinal extensors (**Figure 3C**)	Wall hip abduction isometrics	Quadruped with LE extensions Abdominal brace with arms in air on FR and 90.90 marches	
2		SL squat with wall hip abduction isometrics	Bird dog	
3 – 5	Side glide L4-5 grade III-IV with neural tension (**Figure 3A, 3B**) PA grade III-IV L1-2-3-4	SL deadlift SL stance (sustained SL squat) with row	Bird Dog with resistance	Pike (pain free) with feet on ball (**Figure 4**) Pike (pain free range) with feet in TRX (**Figure 5**)
6 -12	Side glide L4-L5 grade III-IV with neural tension PA grade III-IV with progressive increase in SLR L1-2-3-4	SL deadlift with weights	Sciatic nerve glides (knee extension with ankle dorsiflexion) supine with Lacrosse ball in back (L1-2-3-4)	Hanging hip flexion/pike while back supported by swiss ball.
13-16	Side glide L4-L5 grade III-IV with active neural tension MFD Hamstring and posterior back line (**Figure 2D**)	Deadlift with weight		Eccentric Lumbar extension off table Pike (pain free) with feet on ball Pike (pain free range) with feet in TRX

Abbreviations: FR, foam roller; LE, lower extremity; MFD, myofascial decompression; NMR, neuromuscular reeducation; SL, single leg; Ther Ex, therapeutic exercises

Figure 3. Photos of Patient Treatment

A, The neural tension techniques, termed "sliders" and "tensioners", combined with lateral lumbar mobilizations. B, Sliders and tensioners combined with lumbar posterior-to-anterior at L1–4. C, Myofascial decompression in bilateral lumbar extensors with movement. D, Myofascial decompression on lumbar extensors and sciatic nerve pathway.

was replaced by the tuck position, allowing the hips to abduct and externally rotate, improving hip flexion angle without driving the lumbar spine into flexion. This resulted in a decrease in shearing forces at the L4-5 level, the root of her symptoms.

The order of acts in the circus school's upcoming performance was modified to allow recuperation between acts. Contortion in a small box was an element the patient did as part of the show prior her regular hoop diving routine. Small box contortion required the patient to fold at the hips, knees bent, inside a piece of luggage while being transported by another performer. During training, the patient reported transient back discomfort to her coach following box contortion and hoop diving in close succession. The coach's understanding of the pathology prompted proactive adjustment of the show order to place box contortion in an earlier part of the show to allow adequate recuperation between acts.

Knowledge acquired of the pathology allowed performer and coach to establish effective and informed decision-making tools. Future plans to train in contortion were indefinitely put on hold based on a comprehensive understanding of both the patient's condition and the specific demands of contortion acts. Proactive training management through an understanding of the limits of functional rehabilitation and the pathology along with performance demands allowed effective decision making that was productive for both current training loads and long-term career goals.

Outcomes

Over the 8 weeks of 16 treatment sessions, after the 5th visit, the patient reported no longer having constant pain. The intermittent pain decreased from 7/10 initially to no more than 3/10, by the 10th visit, lasting only a moment while performing the pike movement dynamically while tumbling (with or without hoop diving). The test-retest measures were also symmetrical at that time for the SLR to ~125° without symptoms. Treatments were continued beyond focusing only on pain reduction in order to improve her endurance and ensure sustainability through the increased training and rehearsal time for her upcoming performance. She was able to successfully participate in her show, which was just after the 16th and final visit.

DISCUSSION

Biomechanical analysis of the physical therapist and the acrobatic coach will each yield their own analysis. The success of this patient's treatment plan relied heavily on two primary aspects. This two-armed approach comprised of consideration for the unique biomechanical demands of the sport and inter-professional management with the patient's acrobatic coach. Due to the anatomical change or fixed nature of a lumbosacral transitional vertebrae, the patient needed to modify her acrobatic movement elements by decreasing the overall flexion forces through her spine. The patient also demonstrated difficulty with gluteal recruitment during functional activities and sport; poor single leg squat, Trendelenburg, and video analysis of landing and take-off provided evidence in support of strengthening and addressing motor control. Improved take off and overall improved movement control was achieved by targeted closed chain exercises in the clinic after using manual techniques to decrease symptoms and neural tension.

Collaboration with the patient and the acrobatic coach was an essential aspect, critical to the successful treatment plan. The acrobatic coach contributed a relevant body of knowledge and know how, willingly partnering to effectively assist the acrobat in bridging the gap between mastering rehabilitative exercises in the clinic and integrating them into her movements on the stage. Knowing what was realistic for the performer and modifying acrobatic demands was necessary, as was integrating the proper form in functional movements from physical therapy. This would not have been possible without collaboration with the patient and the acrobatic coach. Developing a strong collaboration between the performer (patient), the coach and the physical therapist allowed decision making to successfully manage the care of the patient's current condition and foster a climate of trust for the long term should other concerns or questions arise.

CONCLUSION

In conclusion, by working as a team of coach, performer, and physical therapist, potential problematic acrobatic movements were identified and modified, training to protect and strengthen the patient's spine was designed and adapted, and the order of the show performance element was changed to maximize recuperation without losing show

Figure 4. Pike with feet on ball

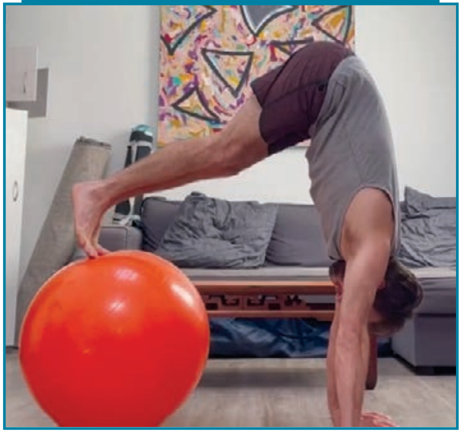
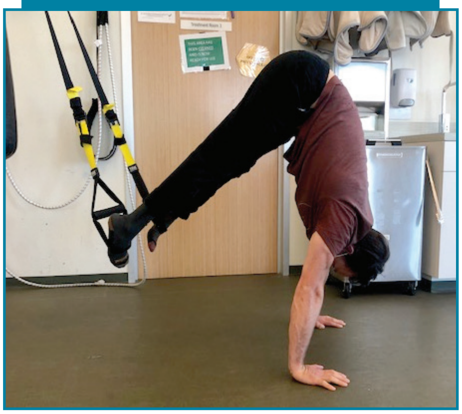


Figure 5. Pike with feet on TRX



quality. Bertolotti's syndrome in pediatric circus acrobatics can be painful and limiting to flexion-related tricks that an athlete must perform. Standard physical therapy with utilization of mobilizations, strengthening, and soft tissue manipulation is indicated, but this special population demands additional consideration for a successful plan of care. In-depth biomechanical assessment and task modification when necessary must be considered. Effective collaboration between coach, physical therapist, and performer is paramount to achieving best outcomes.

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A Primer on the Handstand: Basic Technique and Common Issues

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ABSTRACT

Background: The handstand is a skill that has become common to a variety of competitive, performance, and recreational activities. As the quality and safety of handstand instruction and practice varies considerably, improper technique or progression can increase the risk of injury. **Purpose:** The purpose of this work is to provide a brief overview of the handstand, and to highlight common postural and functional issues that arise when learning the handstand. **Methods:** This commentary first introduces basic handstand biomechanics, followed by a description of proper and effective use of different regions of the body. Range of motion, strength, and knowledge deficits are then highlighted in correspondence to the potential resulting compromised handstand posture. **Clinical Relevance:** An improved understanding of proper and improper handstand technique, as well as knowledge of common deficiencies, can assist clinicians in understanding areas of the body that may be loaded excessively, identifying root causes, and treating handstand-related injuries.

Key Words: circus, gymnastics, inverted stance, overhead shoulder

INTRODUCTION

The handstand is a skill that is most well-associated with gymnastics where it is momentarily held or is a position within a dynamic skill. Handstands have also increasingly become practiced by many for recreation, enjoyment, and fitness, whether it be for circus, yoga, CrossFit, or calisthenics. From a technical perspective, there are notable differences in the purpose, look, and function of the handstand in these activities, though the stereotypical handstand is one where the arm-supported and inverted posture is held quasi-statically with a straight and roughly vertical body. This version of the handstand, similar to that performed in gymnastics and handbalancing in circus, will be the focus of this article.

The process of learning a handstand requires a progressive approach to developing sufficient strength, flexibility, sensory integration, coordination, and confidence, among other capacities. Individuals often come to learning a handstand with deficiencies in one or more of these categories, and the appropriate prescription of drills is necessary for progression. Performing drills that are beyond an appropriate working level, or attempting a freestanding handstand without a sufficient foundation, will often result in moderate or severe breakdown in technique. Inappropriate drill prescription and progression is often a result of deficient understanding of fundamental handbalancing concepts, physical training, cueing and language, etc. In such cases, there are aesthetic and functional consequences, such as increased stresses placed on various parts of the body as well as an increased risk of injury.

This article aims to first provide a very brief introduction to handstand technique, and second to communicate how common issues and deficiencies affect handstand quality, posture, and the potential for injury. The focus will be on identifying functional deficiencies or limitations based on the performance or posture of the handstand. Details of the handstand can be discussed at length, though this article will focus primarily on upper body, upper limb, and gross functional issues from an admittedly high-level perspective to provide foundational knowledge to individuals that may see and treat handstand-related injuries.

THE HANDSTAND: AN OVERVIEW

Basic Biomechanics

A fundamental understanding of biomechanics and quiet stance is essential to understanding the handstand and the compensations that may result from physical or knowledge deficits. The goal of a basic 2-arm handstand can be seen as maintaining quiet balance while in a near-straight and near-vertical, arm-supported posture. A biomechanical requirement that must be fulfilled at all times for balanced stance is that the vertical projection of the center of mass (COM) of the body lies within the base of support,[1] that being the hands when in a handstand. The idealized single inverted pendulum model is useful to understand details of balance.[2] Inverted quiet stance can be characterized primarily by an anterior-posterior sway (where anterior is the direction the fingers point in the handstand).[3,4] The average COM lies just anterior to the axis of rotation, often resulting in a slight forward tilt of the body. Controlling balance is primarily done by generating a torque about the axis of rotation, that being the wrists in the handstand.

Fundamental and necessary characteristics of balancing a handstand include structure throughout the body and controlling balance. Structure can be defined as having a strong and rather rigid connection between the wrists and the toes (the most superior point of the handstand) that can remain stable even in the presence of small disturbances throughout the body. Such structure effectively reduces the body to a single degree-of-freedom inverted pendulum, and in doing so, isolates and simplifies control to torque about the wrists. Sufficient structure is often achieved through alignment with near 180° shoulder flexion, scapulothoracic stability primarily through scapular elevation, and mid-section and lower limb engagement while maintaining a straight spine.

The control of balance in a handstand can be viewed as a spectrum with gross control on one end and calm control on the other.[5,6] Gross control can be defined as mostly involuntary and large movements at the shoulders, elbows, spine, hips, and knees that occur in a rather delayed and anxious manner where there is little confidence that such actions will maintain balance. Calm control can be defined as the use of isolated torque about the wrists that produce strong, confident, and almost proactive adjustments to finely manipulate the body as a whole. Learning to balance a freestanding handstand comes with improving balance proficiency by moving from the body's default approach of gross control to one of calm control.

While the relationship between structure through the body and balance control is somewhat evident, it should be acknowledged these qualities have a bit of a symbiotic relationship. If sufficient structure cannot be found throughout the body, balance control will likely revert to gross control, especially in novice individuals. Only with finding sufficient structure through the body is calm control possible, though strong and confident calm control through the hands and fingers will also encourage one to maintain a solid and unified structure through the body.

Set-up and Positioning

While the legs and hips are made for weight-bearing support, the arms and shoulders must be used in a manner for which they are not designed. The shoulder, often described as a joint with considerable range of motion that lacks stability,[7] must be able to bear half of one's bodyweight while creating sufficient stability at the scapulothoracic and glenohumeral joints. Scapulothoracic strength and stability is often a primary deficiency and a weak link for many learning a handstand, and this negatively impacts overall body structure and balance control. The general position of the scapula should be elevated with accompanying protraction, along with the natural upward rotation that comes with humeral elevation.[8] The intention is to create a stable foundation at the shoulders that in turn creates the necessary strong connection between the hands and fingers and the rest of the body, thus enabling calm control. Most novice individuals must attempt to elevate their scapulae near maximally, as this use and level of activation is not common to activities of daily living. More experienced or stronger individuals can find sufficient scapular elevation and stability with sub-maximal effort. The shoulders should be at or near 180° of flexion; using 180° of flexion will result in a slightly forward-tilted handstand (**Figure 1A**), while flexion just shy of 180°, accompanied by slight thoracic flexion and 'hollowing' of the chest, can align the body vertically with slightly forward-tilting arms (**Figure 1B**). This second position may be considered more technically correct in some schools of thought, though either variant will allow for achieving a high ability level.

The hands should be placed approximately shoulder-width apart with the index or middle finger pointed forward and the fingers spread comfortably, but not excessively, wide. Various finger postures can be used, though common postures include flat fingers, engaged fingers with slightly flexed proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints, and tented fingers that use metacarpophalangeal (MCP) extension, PIP flexion, and DIP extension. The selection of finger posture is often based on comfort, though it is critical that the fingers can contribute functionally to balancing. More specifically, the hands and fingers must become a rigid unit that produce downward-directed force to generate wrist flexion torque to counter the torque generated by the body's COM that lies slightly forward of the wrist axis of rotation. The location of the applied downward force in the hands or fingers to generate this wrist torque can vary, though focusing the force application through the fingertips results in the longest lever arm (and functional base of support) between the axis of rotation and the point of force application.

The position of the balance point, or the anterior-posterior location of the average center of pressure (COP), under the hands and fingers often depends on the ability of the individual. The magnitude of the COM anterior-posterior displacement is bounded anteriorly by the force the hands and fingers can apply into the ground to counter forward-leaning tilt and posteriorly by the axis of rotation at the wrists. Additional anterior or posterior displacement of the COM beyond these bounds requires quick and gross movements of the body and limbs to salvage balance and remain inverted. Less skilled individuals may have a COP that is more forward on the palm due to feeling increased control through substantial hand and finger use, which can offer a fair margin of error both in body control and balance control in spite of its inefficiency in energy expenditure. More advanced individuals will have better body control and greater precision in managing sway, and the balance point can lie further rearward on the palm closer to the axis of rotation.

The head position should be such that the neck is in slight extension to glance at a focal point on the ground centered between the hands when elevating the eyes (ie, peering upwards). The position of the focal point can generally lie somewhere between the fingertips and even a few inches behind the palms. Exceptions can be made in some cases, but this is appropriate guidance for most novices. Using a fixed focal point on the ground located beneath the head very clearly allows one to use a visual reference to understand how the body is moving when inverted due to the sway in a handstand being roughly parallel to the ground.[9,10] The use of a neutral head position with a distant focal point provides different and less rich visual information to assist with balance, in addition to accompanying vestibular disruptions that occur with a more inverted head position.[11] More advanced individuals should become proficient at balancing a handstand when their head is in any orientation and with the eyes closed, thus negating the necessity of visual information.

As the primary focus of this article is the shoulders and arms, brief attention will be given to the remainder of the body. Sufficient shoulder flexion aids considerably in alignment of the midsection and legs. Finding sufficient structure through the midsection and legs in the novice individual can often be achieved through focusing on a posterior pelvic tilt and using moderate leg adduction, full knee extension, plantarflexed ankles, and pointed toes. The structure found in the mid- and lower-body through these cues then aids in creating whole-body structure. Additional and refined cues are often used as one progresses with improved control and ability.

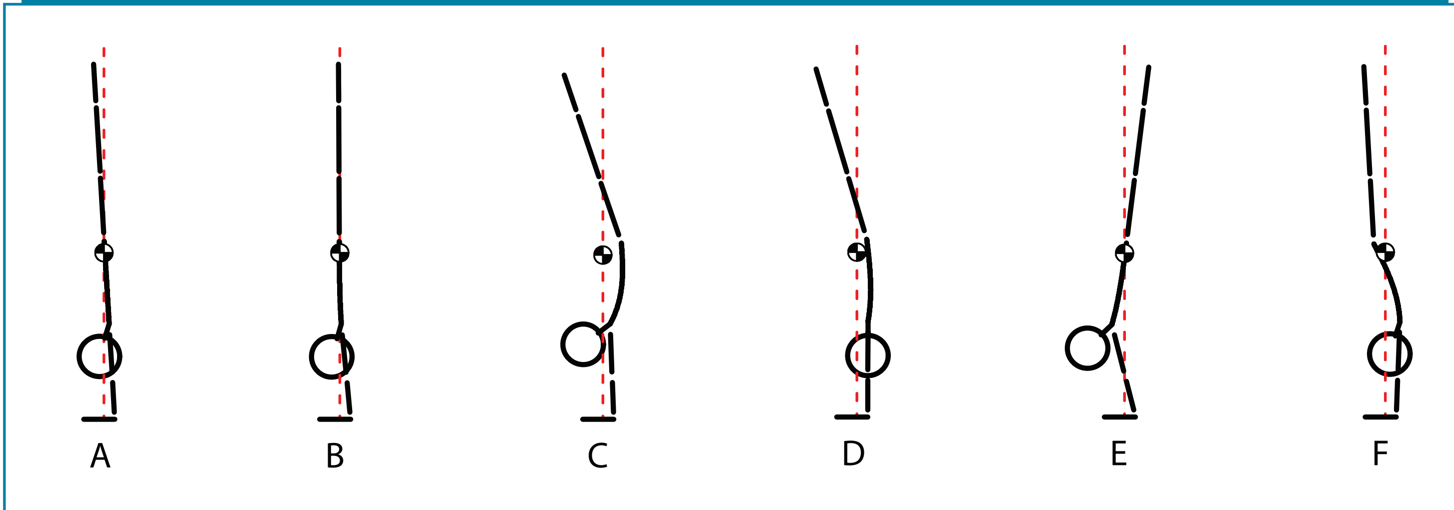
COMMON ISSUES

The position that one places themselves in the handstand and the quality of their balance can be used to identify deficiencies, where these limitations could be related to flexibility, strength, or an understanding of technique and process. Such deficiencies will often be functionally detrimental in some capacity, perhaps completely limiting the attainment of more advanced skills, and in some cases, deficiencies can increase musculoskeletal demands and the risk of injury. Deficiencies described herein include those that are commonly seen in individuals learning a handstand based on their posture and function when attempting to perform a wall-supported, spotted, or freestanding handstand. Additional diagnostic assessment may be necessary to be certain of the actual deficiency and improper postures may simply be suggestive of underlying issues. Multiple deficiencies may occur simultaneously and all must be overcome to enable an efficient handstand. As well, when training a handstand, individuals will inevitably suffer from technical breakdown and use their bodies in ways that require capacities in excess of that which is minimally necessary to execute an ideal handstand. Individuals should therefore have appropriate excess functional capacity in flexibility and strength to reduce the risk of injury during learning. Admittedly, the terms deficiency or insufficient are not defined by quantitative measures, though this section attempts to convey root causes and their associated effects on the handstand in a qualitative manner.

Limited Shoulder Flexion or Thoracic Extension

Limited active shoulder flexion range of motion or limited thoracic extension, or both, can have significant and detrimental consequences to handstand alignment and

Figure 1. Common variants of the handstand, both technically correct (A-B) and incorrect (C-F). Center of mass is shown at approximately the center of the body, the vertical projection of which, the balance point, intersects the mid-palm.



A, Straight, yet tilted handstand that utilizes 180° of shoulder flexion and a straight body from wrists to toes. B, Vertically-aligned handstand that utilizes slightly less than 180° of shoulder flexion and slight thoracic flexion or hollowing. C and D, Handstand postures typically resulting from either limited strength in shoulder flexion or scapular elevation (or both), or from limited range of motion in shoulder flexion or thoracic extension (or both). These limitations result in spine extension and the legs placed over the head to remain on balance, though the posture in D uses a neutral or flexed neck to force the shoulders open. E, Handstand posture common to individuals that have high levels of strength where a forward lean of the shoulders exploits shoulder flexion strength. F, Handstand posture often resulting from limited strength in shoulder flexion or scapular elevation (or both) where the shoulders relax slightly into near end-range of shoulder flexion and hip flexion allows remaining on balance.

function. An inability to align the arms with the torso when inverted will often result in compensations where scapular elevation and stability is deficient, the chest flares out, and there is spinal extension that directs the legs over the head (**Figure 1C**). The neck is often, but not always, placed in extension where the individual is likely attempting to use neck extension to assist with shoulder flexion and scapular elevation. While the COM can still be appropriately placed within the base of support and balance is technically possible, the effort required to hold this position increases significantly through the shoulders and anterior chain compared to someone that is uninhibited by shoulder flexion or thoracic extension limitations. The shoulders may lie forward of the balance point as well, in which case the wrists may be placed into greater extension than that necessary with proper alignment. If one also has limited wrist extension beyond what is necessary to hold a proper handstand, the wrists, hands, and fingers could be at risk of increased loading and injury. Alternatively, individuals may use a neutral or flexed neck to attempt to force the shoulders into sufficient flexion to utilize passive stability that comes with near end-range of motion (**Figure 1D**), which often also results in spine extension and the legs falling over the head. Though there is likely some active use of the anterior chain, the lumbar spine is placed into greater extension than desired, especially while the body is under significant stress due to the challenging nature of the skill and the lack of excess capacity in flexibility. Working handstand-related drills with this lumbar extension is not recommended and the limited shoulder or thoracic flexibility should be a primary focus. Finally, individuals that have a high strength-to-bodyweight ratio can more easily find sufficient scapular stability, though active shoulder flexion may be limited, thus placing the shoulders forward of the balance point (**Figure 1E**). While this may be stable, this is not an efficient handstand.

Limited Strength in Shoulder Flexion and Scapular Elevation

A strength deficiency in either shoulder flexion or scapular elevation, or both, can result in poor body alignment as well as functional issues with structure and balance. From the perspective of body alignment, two resulting body positions are fairly common. The first is characterized by unelevated scapulae and insufficient range of motion in shoulder flexion, where this shoulder flexion deficiency may or may not be due to lack of flexibility (**Figure 1C**). This posture often results in extension through most of the spine that directs the legs over the head, very similar to that previously described. These deficiencies will often result in gross balance control, if one can remain inverted, with larger joint movements at the shoulders and hips, rather than isolated control at the wrists. Differentiating limited strength from limited flexibility in shoulder flexion or scapular elevation can be done by assessing shoulder range of motion in unloaded situations and shoulder use and thoracic posture in less intense inverted variations.

The second body position resulting from deficient shoulder flexion and scapular strength is characterized by excessively open shoulders (at or slightly beyond 180° of shoulder flexion) that partially exploit passive stability that comes when nearing end-range of motion (**Figure 1F**). The shoulders are often rearwards (away from the fingers) relative to the balance point, the back resides in extension, and hip flexion is used to keep the COM from traveling too far forward. This particular position, while fairly efficient and not muscularly taxing, limits how far one can progress because shoulder and scapular stability and positioning does not come primarily from strength.

As mentioned, sufficient scapular elevation is something that nearly all individuals must work toward, and most individuals will be working near maximal levels of effort for some time. Individuals with strength limitations will be tempted to rely on passive stability by either sinking (unelevated scapulae, **Figure 1C**) or settling into the shoulders (**Figure 1F**) because a correct and elevated scapular position may feel less stable due to insufficient glenohumeral and scapulothoracic stability. While individuals may feel comfortable in these deficient positions, continuing to train in such positions may result in shoulders, elbow, wrist, or hand pain due to the reliance on passive stability from near end-range of motion at the shoulders and scapulae.

Limited Wrist Flexibility

Most individuals do have sufficient wrist extension to comfortably begin training a handstand, though performing a thorough wrist warm-up and stretch prior to training handstands, improving wrist strength, and maintaining wrist flexibility will aid in preventing wrist injuries. Some individuals do have limited wrist extension and this can negatively affect the handstand position and control due to the use of an excessive and potentially unstable range of motion at the shoulders and thoracic spine (**Figure 1D** and **1F**). These individuals will likely have a reduced range of sway in normal balance, which consequently reduces the margin for error when balancing and therefore requires greater precision in control at the hands and fingers. As well, the entire body must be well-controlled to avoid destabilizing voluntary or involuntary movements that could affect the magnitude of sway. The placement of the balance point may also be affected such that passive stiffness of the wrists—due to being placed near end-range of motion—may place the balance point rearward toward the base of the palms. While this more vertical alignment may be less intense at the hands and fingers for control, this also requires greater precision in balance and body control to avoid using underbalance corrections or having to step down.

If limited wrist extension occurs with limited shoulder flexion or thoracic extension, working drills that require full bodyweight support near a handstand position may be premature and will likely increase the risk of injury in multiple regions of the body. In such cases, work should be done to increase the usable range of motion to have some functional excess capacity to safely work handstand-related exercises.

Excessively Forward Focal Point

A focal point that is excessively forward (ie, a few inches in front of the fingers or more) or looking at a focal point without using eye elevation can result in unnecessary neck extension and limited shoulder flexion (**Figure 1C** and **Figure 1E**). Limited shoulder flexion has downstream effects as described above. Improving the handstand posture of an individual that has used this technique for some time may not simply be accomplished by changing the focal point, as shoulder flexion and scapular elevation strength may not be sufficiently developed.

Ineffective Hand and Finger Use

A common issue at the hands and fingers is improper or ineffective use to control balance. As mentioned, proper and effective control by the hands can be accomplished by producing a downward-directed force through the fingertips to generate a flexion torque about the wrists. Individuals that lack finger flexion (primarily at the MCP joints) and wrist flexion strength in this manner, or that lack structure through the body, will often attempt to cup or grip the floor by pulling the fingertips back towards the palm. This approach may impose greater force production demands at the fingers due to the misdirected and diagonal force vector through the fingertips, and it generates minimal wrist torque and limits one's ability to control balance in a calm manner. Ineffective use of the fingers may also result in a balance point that is placed too far rearward near the base of the palms as the individual is reluctant to load the fingers properly using a more normal and forward balance point due to the lack of confident control at the hands and fingers. Such a rearward balance point may also limit shoulder flexion and scapular elevation, thus resembling a save strategy when falling into underbalance where the individual attempts to pull their weight forward onto balance. It is important to note that proper and effective use of the hands and fingers for balancing is something all individuals must develop as this posture-specific use of the hands and fingers is not common to any activity of daily life.

Inefficient Balance Point

A balance point that is too far forward will require increased wrist torque, and thus finger flexion and wrist flexion muscle force, to sustain balance. Such a forward balance point often results from insufficient shoulder flexion with either back extension and hip extension or a straight spine and straight hips. A forward balance point could also result from a relatively straight body (180° shoulder flexion, no hip flexion), but an excessive whole-body tilt, though this is less common due to the strength and skill necessary to maintain a straight body position. The necessary increased wrist torque could place extra stress on the fingers, hands, and wrists, and balance will likely not be sustained for long. A balance point that is too far rearward will often result in the same compensations as those described above for improper use of the hands and fingers. Finding an appropriate balance point involves understanding the tradeoff between allowing sufficient anterior whole-body tilt for a manageable margin of sway while also limiting anterior whole-body tilt to minimize excess stress and work in the hands and fingers.

Neutral or Flexed Neck

Individuals with limited shoulder flexion or thoracic extension may try to force these areas open by using a neutral or flexed neck (**Figure 1D**), thus placing their focal point at a distant object. While this may be effective for finding greater shoulder flexion and thoracic extension, these areas will rest in weak passive stability and will likely compromise stability and structure throughout the body.[11] Individuals without insufficient shoulder flexion or with thoracic limitations may also use this head position, and this is often a result of not understanding the value of a fixed reference point that is between the hands and directly beneath the head.

Posterior Chain Inflexibility

As the body is under considerable tension in the handstand due to the nature of the skill, posterior chain tightness can affect one's ability to find even a straight handstand position, let alone other, non-straight positions. Individuals that are tight through the low back and the legs will often have limited shoulder elevation and posterior pelvic tilt, which have downstream consequences and potentially limit handstand-specific exercises that can be performed safely. In such cases, improving lower body flexibility is critical to finding appropriate upper body alignment and structure.

SUMMARY

A critical first step in overcoming structural and functional deficits in the handstand is the identification of range of motion, strength, and knowledge limitations in individuals. The posture in which one places themselves when in a handstand can provide insight to identifying underlying deficiencies. While teaching the handstand and knowing how to address such limitations can be complicated and comes with experience, this article aims to provide an elementary introduction of how the handstand works from a structure-function perspective. The deficiencies and limitations discussed herein include those common to individuals learning a handstand, and while not an exhaustive list, this information can be used to understand how deficiencies in functional capacities negatively impact, and potentially risk, regions of the body.

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Injury Patterns in Subgroups of Circus Artists by Circus Discipline: A Pilot Study

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ABSTRACT

Background and Purpose: Circus injury research is limited. The purpose of this pilot cohort study was to describe injury frequency and characteristics related to specific circus discipline and similar sub-groups of artists based on discipline-specific physical stresses using the established IADMS injury surveillance guidelines and a novel classification for circus disciplines. **Methods:** Twenty-four circus artists [20 female mean (standard deviation) age 19.4 (7.7), 4 male 31.3 (2.5)] enrolled in the study. Participants were followed for one year. They submitted a weekly circus training log and circus-related injuries were assessed. **Findings:** Twenty-one participants completed the study (87.5%). Over the year, 47 total injuries were reported with an overall injury rate of 5/1000 exposures. Ground acrobatics was associated with 53.2% of all injuries. **Clinical Relevance:** Performing arts physical therapists should understand circus injury patterns and physical stresses related to different circus disciplines. **Conclusion:** Injury prevention strategies should initially focus on ground acrobatics.

Key Words: acrobat, circus, injury

BACKGROUND AND PURPOSE

Historians characterize the start of modern circus by when acrobats started performing in a circus ring in the 1700s in Europe, and the 1800s in the United States.[1–3] Today, some circus performances still take place in a circus ring or under a big top tent, but acrobats also perform in theaters, concerts, nightclubs, street fairs, and corporate events. The seemingly superhuman skills performed by circus acrobats are the result of years of intensive training to gain the required strength, flexibility, and motor control. Over the last decade, participation in circus arts has rapidly grown in popularity in the United States, both as a professional art form and a recreational activity.[4] Despite the growth, there is a lack of circus research to guide strategies for decreasing injury risk for these artistic athletes.

Injury surveillance, to understand injury etiology is a critical foundation for developing injury prevention strategies.[5] Circus is early in its understanding of injuries compared to similar activities like dance or gymnastics,[6–15] and must rely on research from sports and dance medicine to guide injury prevention and rehabilitation despite the unique characteristics and context of the circus arts. The first longitudinal circus injury study was published in 2009,[16] and showed a medical attention injury rate of 11.2/1000 performances in professional acrobats, of which 39% were in female performers. By comparison, injury rates for women's college gymnastics are 9.22/1000 athletic exposures including training and competition.[8]

Current variability in circus injury surveillance methodologies[16-21] makes it difficult to compare findings or extract injury patterns that can guide injury prevention research. In a systematic review, Wolfenden and Angioi[21] highlighted differences for injury definitions (time loss or medical attention), measures of exposure (number of performances, hours, or athletic exposures), and participation level (student to professional). Similar inconsistency in dance injury research prompted the development of the International Association of Dance Medicine and Science (IADMS) Standard Consensus Initiative guidelines,[22] which made specific recommendations for best practices in testing and reporting injuries in dance. Since dance is a performance art that requires a high degree of athleticism, these guidelines could inform the standardization of circus injury research.

Some of the variability in circus injury reporting is due to the complexity of circus, including the wide breadth of acrobatic disciplines, spanning from juggling to high flying trapeze. Circus artists often train in multiple disciplines, but the combination of disciplines varies between artists. Mechanical stresses, such as impact forces with tumbling versus stabilization at end range with contortion, also differ between disciplines. Unlike sports, circus lacks large homogeneous groups of athlete artists. Hence, there is need to categorize circus disciplines with similar physical stresses for injury surveillance and to guide future injury risk-reduction interventions.

In circus, the highest injury incidence (35-36%)[16,17] has been reported in the lower extremities, with the ankle as most common.[16-18] Munro[18] found ground acrobatics/tumbling as the most common mechanism of injury in professional circus students possibly related to greater exposure. Another study of circus students found approximately 50% of injuries were due to floor acrobatics, but specific disciplines were unclear.[17] The floor event has also been associated with the greatest number of injuries in artistic gymnastics.[8,10] Understanding the influence of circus discipline on circus injuries is necessary to appropriately target risk reduction interventions.

To allow for meaningful comparison, researchers have attempted to categorize circus artists for injury analysis.[16,17,19] Shrier et al[16] divided professional artists into acrobats, non-acrobats, and musicians. Hamilton et al[19] further subdivided acrobats into sudden load, if the primary act "required high compression or distraction loads" or non-sudden load, if it did not. Physical stresses from traction or pulling with aerial acrobatics are different than the weight-bearing and impact-related forces in ground acrobatics so this sudden load classification still includes a heterogeneous group. Wanke et al[17] divided disciplines into floor and apparatus groups. The apparatus group included tightrope and slack line that have forces similar to most ground acrobatics. Barlati[23] considered the "type of apparatus or rigging used and the skills and abilities required to practice them" to define the categories: aerial acrobatics, balancing, juggling, clowning, equestrian, and floor acrobatics. With this categorization, some disciplines fit more than one category, and in some categories, eg, floor acrobatics, the disciplines included have a broad range of physical stresses, thus limiting the utility for injury analysis.

The purpose of this pilot cohort study was to describe injury frequency and characteristics related to specific circus discipline and similar sub-groups of artists based on discipline-specific physical stresses using the established IADMS injury surveillance guidelines[22] and a novel classification for circus disciplines.

METHODS

The Samuel Merritt University Internal Review Board approved this study (SMUIRB#17-013).

Participants

A sample of convenience was recruited from a 24-member (22 female, 2 male) youth pre-professional training program and 55 (44 female, 11 male) adult coaches employed at Kinetic Arts Center, a circus training facility in Oakland, California. The pre-professional training program included 11 months of multi-disciplinary circus training for a minimum of 6 hours per week, participation in a full-length show that ran for 16 performances, and several additional community event performances. The adult coaches were freelance circus professionals at different stages of their professional careers who trained regularly. Prior to participation, adult participants signed an informed consent, youth participants signed an adolescent assent form, and their parents completed an informed consent. Exclusion criteria included a planned absence exceeding one month, lack of regular circus training, or age younger than 13.

Design

The IADMS guideline was adapted for use in this circus context.[22] First, the guideline recommends mandatory injury reporting.[22] No medical staff or mandatory injury surveillance system existed at the circus training facility, so injury surveillance was limited to self-report by study participants. Second, the guideline recommends use of time loss (TL) and musculoskeletal complaint injury definitions.[22] Time loss was adopted and the musculoskeletal complaint definition was expanded to include injuries to other body systems not resulting in TL, such as concussion. Injury classification by a health care professional was also recommended[22] and included in this study. The third and last recommendation in the guideline was to define one exposure as participation in a single class, rehearsal or performance.[22] Self-directed training was added as another session type since circus artists often do additional independent training outside of class and rehearsals.

Rolling enrollment in the study took place from September to December 2017. Enrollment included a single visit for completion of informed consent/assent forms, an intake questionnaire, and physical examination that integrated elements of the Dance USA[24] and National Institute of Circus Arts screening guidelines.[25] The intake included questions about age, gender, training experience, medical, and injury history. The author, a licensed physical therapist, conducted the baseline physical examination that included height, weight, Beighton score,[26] measures of flexibility, balance, and strength. For grip strength, participants were seated at the edge of the table, shoulder/forearm neutral, elbow flexed to 90°, and wrist slightly extended and ulnarly deviated.[27] The JAMAR® hydraulic hand dynamometer handle was set to position 2.[27] Three trials each side, alternating sides, were recorded in kilograms. For the handstand, participants were allowed 1-2 practice trials and to use any leg position with a vertical trunk (ie, no contortion positions). They were allowed 2 trials and best time was recorded. Pull-ups were performed with pronated grip on a trapeze from a full-hang with elbows extended to chin over the bar. One trial was allowed, with number of complete repetitions recorded. Single limb balance was performed on a firm surface, arms crossed, and hip flexed to 90°. Two trials were given for each side, with maximum time recorded. Hamstring flexibility assessment was done lying on a plinth, using a passive straight leg raise. The examiner palpated the ipsilateral anterior superior iliac spine, then flexed the hip, knee fully extended, until posterior pelvic tilt occurred. The angle was measured at the distal tibia using an inclinometer.[28]

Participants were tracked for 1 year following their individual study enrollment date, with the last enrolled participants completing the study in December 2018. Participants received an email with a Qualtrics link (Version 9/2017-12/2018, Provo, UT) to complete an online training log each week for 52 weeks following their enrollment date. In this training log, they reported weekly exposure as total number of sessions (classes, rehearsals, performances, or self-directed training) for each circus discipline. They also reported total time per week for each circus discipline. Participants reported any new or ongoing injuries, and any missed training sessions due to injury in this log. For any new or recurrent injuries, the author conducted an interview and physical examination to determine the associated circus discipline, body region, tissue, and nature of the injury. Injuries that were present prior to study enrollment were recorded in the intake history but not included for calculating injury frequency unless an exacerbation occurred. Injuries that were not attributed to circus training were noted, but not tracked. Treatment was not included as part of the study.

Injury Classification

Injury was defined as an impairment at the "anatomical tissue-level."[22] Time loss injury was an injury that resulted in full loss of participation, in at least one circus discipline, for one or more days from the injury onset.[22] Any injuries that did not meet the criteria for TL were defined as non-time loss (NTL). New injury was in a body region and of a nature that had not occurred within the last 2 months.[29-30] Recurrent injury was in the same body region, of the same nature, within 2 months of returning to 100% participation after a TL injury.[29-30] Traumatic injury was related to a specific macro-traumatic event (eg, fall, awkward landing).[31] Overuse injury was related to repeated exposure to a micro-trauma (eg, movement, position, or activity).[31]

Circus Discipline Classification

For an individual participant, primary circus disciplines were defined as any discipline trained for 2 or more hours a week during the 6 months prior to study enrollment. The author created a classification of acrobatic circus disciplines (**Table 1**) informed by the previous categorizations.[16,19,23] The intent of this classification was to group disciplines with similar physical demands so related injury patterns and later injury prevention strategies would be linked to the group of artists most likely to benefit. Aerial acrobatics includes circus disciplines in which the acrobat spends a majority of time suspended from an apparatus, commonly uses pulling movements, and inverts on or climbs the apparatus. Aerial acrobatics with ground elements are a subset of aerial disciplines that often also include impact movements in contact with the floor or apparatus and/or pushing movements. Ground acrobatics (human populsion) involve acrobatic skills with jumping, diving, or tumbling type movements that might be similar to gymnastics, where height from the ground is due to human propulsion. Ground acrobatics (apparatus propulsion) involves an apparatus or other non-human device that imparts increased acceleration often resulting in landing from significant height. Ground acrobatics (balance/control) typically involves weight bearing on a stable or unstable surface (apparatus or human) with the focus on creating

Table 1. Acrobatic Circus Discipline Classification

Circus Discipline Sub-Groups	Definition	Examples of Disciplines
Aerial acrobatics	Circus disciplines in which the artist is often suspended from an apparatus by various body parts, and commonly uses pulling movements, inverts on or climbs the apparatus.	**Silks (akaTissue/Fabric)*** **Rope (aka Corde Lisse)*****/Spanish Web** **Trapeze (Static, Dance, Flying)*** **Aerial hoop (aka Lyra)*** **Sling/Hammock*****/**Cloud Swing/ **Straps*****/**Loop Straps **Rings (Russian or Gymnastic)** **Aerial pole**
Aerial acrobatics (with ground elements)	A subset of aerial acrobatics which often also includes impact and/or pushing movements in contact with the floor or apparatus.	**Chinese pole*****/**Dance Pole/Lollipop Russian cradle base High Bar
Ground acrobatics (human propulsion)	Disciplines that involve repetitive skills such as jumping, diving, rotational or other gymnastics type movements where height from the ground is due to human propulsion.	**Tumbling/Parkour*** **Icarian Games*** Banquine Hoop Diving Cyr/German Wheel **Dance***
Ground acrobatics (apparatus propulsion)	Similar to above except that repetitive movements are performed on an apparatus or with a device that imparts acceleration of the artists' movement that often results in landing from significant height.	Teeterboard Russian swing **Trampoline*****/**Tramp Wall Wheel of death **Bungee/Harness*** Trick riding (bicycle, motorcycle)
Ground acrobatics (balance/control)	Includes disciplines where the artist is typically weight bearing on a stable or unstable surface (apparatus or human) with the focus on creating postures or shapes with control and balance. May involve some impact transitioning into and out of postures or on and off base/apparatus.	**Contortion*** **Handbalancing*** **Hand to hand/Adagio/Acrodance*** **Human Stacking*****/**Pyramid Rola Bola/Rolling globe Wire (tight, slack, high) **Stilts***
Manipulation	These disciplines involve the artist creating repetitive movements with an object and often requires significant use of fine motor skills and/or coordination.	**Juggling*** Diabolo/Poi Hooping Knife throwing
Character	Disciplines that often include significant acting and theatrics. It may also include some acrobatic skills but typically with low physical demand.	**Clown*** Ringmaster Mime

*Disciplines trained by the study participants during the study period.

and moving through postures or shapes with control and balance. Manipulation involves the artist inducing movement into an object and often requires strong fine motor skills and coordination. Character includes clowning, mime, and ringmaster roles that often involve significant time on stage, sometimes include acrobatic skills, but often low in physical demand.

Data Analysis

Descriptive statistics were conducted using Microsoft Excel 365 (version 2008, Redmond, WA) for various measures including selected baseline intake and physical examination data, injury rate (frequency per exposure), frequency, and types comparing participants in subgroups by sex and primary circus discipline. Injury rates were calculated per 1000 sessions of all types of circus training.

Results

From the convenience sample of 79 potential participants, 24 enrolled [20 female mean (standard deviation) age 19.4 (7.7), 4 male 31.3 (2.5)] and 21 (17 female, 4 male) completed the study. For the 3 dropouts, the first left after 8 weeks due to illness, the second ceased participation due to leaving the pre-professional training program after 14 weeks, and the third when ceased tracking training after 36 weeks in the study. Of note, one of the dropouts sustained an injury during the period of their participation. All participants that enrolled in the study (n=24) were included in the results except where noted.

Participant characteristics

In the 6 months preceding the study, most study participants trained in more than one primary discipline (mean 3 ±1.35, range 1-5). The participants were divided into aerial, ground, and mixed subgroups based on these primary disciplines. Although no participants had manipulation or character as a primary discipline, 2 or more hours of training per week, several participants trained them regularly.

Demographic and physical examination data at baseline are shown in **Table 2**. Most participants had both aerial and group primary disciplines (n=14, 58.3%), categorized as the mixed subgroup. The entire cohort was predominantly female (n=20, 83.3%). The male participants (n=4) were evenly distributed between the ground and mixed primary discipline subgroups. The average number of performances in the year prior to the study was skewed for the male and mixed subgroups by one participant who had 175 performances in the prior year. The following comparisons are between all subgroups, including disciplines and sex. The male subgroup had the highest average grip strength and pull-up repetitions. The mixed and female subgroups had greatest average straight leg raise hamstring flexibility. Average handstand balance duration was highest in the ground subgroup, but single limb balance with eyes closed was best in the mixed and male subgroups. The highest proportion of participants meeting the Beighton criteria of 5/9 or more for generalized hypermobility was in the mixed, followed by the female subgroups.

Exposures

Total and weekly exposure by number of sessions (training and performances) are shown in **Table 3**. Participants had difficulty determining time by individual discipline so tracking time was discontinued at week 14 of the study period. See Greenspan's 2021 article for discussion on this point.[32] During the study period, the aerial subgroup had the lowest average total session exposure for aerial, ground, and all disciplines combined. They were the only group to participate in clowning (character) and their volume of average ground exposure exceeded aerial exposure. The ground subgroup had highest average total exposure for all ground disciplines and all disciplines combined. The mixed subgroup had the highest average exposure to aerial disciplines, manipulation, and strength training. The average exposure to aerial and ground disciplines was similar within the mixed subgroup. Only one participant in the ground group had exposure to ground acrobatics with apparatus propulsion.

Injury Rates

The overall injury rate for all participants, combined for TL and NTL injury, was 5 per 1000 session exposures. Injury rate (excluding the dropouts) was 2.35 for the aerial group, 7.0 for the ground group, and 3.84 for the mixed group per 1000 session exposures. All male participants reported multiple injuries (range 4-5 injuries) versus 6/20 female participants (range 2-6 injuries). From the baseline intake data, there was a trend between a history of disordered eating/amenorrhea and higher injury rates.

Injury Type

There were 47 total circus-related injuries (53.2% TL, 46.8% NTL) reported across

Table 2. Baseline Demographic & Physical Examination Findings

	Subgroups by Primary Circus Disciplines			Entire Cohort	Subgroups by Sex	
	Aerial n=7	Ground n=3	Mixed n=14	All n=24	Female n=20	Male n=4
Female sex	100%	33.30%	85.7%	83.30%	100%	0%
Age (years)	16.3 (4.9)	30.3 (0.6)	22 (8.9)	21.4 (8.3)	19.4 (7.7)	31.3 (2.5)
Height (cm)	164.9 (9.4)	171.2 (6.2)	164.5 (7.3)	165.5 (7.8)	163.8 (7.3)	173.7 (5.0)
Mass (kg)	55.1 (7.3)	63.0 (12.1)	58.9 (9.0)	58.3 (8.9)	56.4 (7.5)	68.2 (9.8)
Circus experience (years)	5.7 (1.4)	13.3 (5.0)	6.9 (4.4)	7.3 (4.4)	6.6 (3.6)	11.0 (6.8)
Performances prior year	17.4 (8.5)	21.0 (20.1)	24.2 (39.6)	21.7 (30.4)	15.1 (11.2)	53.5 (66.3)
Peak Grip L (kg)	23.4 (3.8)	27.7 (5.9)	30.9 (7.7)	28.3 (7.2)	27.1 (5.7)	34.5 (11.1)
Peak Grip R (kg)	26.0 (4.2)	30.3 (2.9)	30.1 (6.3)	28.9 (5.6)	28.0 (4.5)	33.8 (8.4)
Pull-ups (repetitions)	4.3 (3.2)	10.0 (3.5)	7.8 (3.0)	7.0 (3.6)	6.3 (3.1)	10.8 (3.8)
Single limb stance L (secs)	28.9 (17.8)	32.0 (17.6)	35.9 (20.0)	33.3 (18.6)	31.9 (18.4)	40.5 (20.3)
Single limb stance R (secs)	24.4 (18.8)	32.3 (24.8)	39.9 (18.7)	34.4 (19.8)	33.9 (20.2)	37.3 (20.4)
Handstand balance (secs)	6.9 (13.0)*	45.3 (14.0)	33.9 (27.2)	27.4 (26.0)*	25.0 (25.5)*	39.8 (28.3)
Straight leg raise L (°)	73.9 (8.1)	65.0 (13.2)	83.8 (12.5)	78.5 (13.0)	81.1 (12.0)	66.0 (11.2)
Straight leg raise R (°)	78.3 (11.0)	71.7 (16.3)	82.9 (11.7)	80.1 (12.1)	81.7 (11.4)	72.5 (14.5)
Beighton score >4/9	28.5%	33.3%	50.0%	41.7%	45.0%	25.0%

Aerial and ground subgroups included participants with primary disciplines only from aerial or ground acrobatic disciplines (see Table 1) whereas the mixed subgroup had primary disciplines in both. Female sex and Beighton score are represented as a percentage of the group. All other measures are given as mean (standard deviation). *One female participant, part of the aerial primary discipline group, was not able to perform the handstand assessment in the initial screen due to an ongoing wrist injury.

Abbreviations: cm, centimeters; kg, kilograms; yrs, years; secs, seconds

Table 3. Total and Weekly Exposure to Circus Training

	Aerial (n=5)	**Ground** (n=3)	**Mixed** (n=13)	**Total** (n=21)
Total sessions/participant				
All	339.6 (±65.6)	714.8 (±146.7)	540.1 (±109.3)	517.3 (±109.7)
Aerial	92.8 (±52.6)	92.2 (±191.3)	173.6 (±184.7)	142.7 (±159.1)
Aerial with ground elements	0.00	18.4 (±53.3)	89.4 (±31.3)	70.7 (±27)
Ground (human propulsion)	102.2 (±68.5)	260.5 (±117.3)	92.6 (±46.2)	118.8 (±84.3)
Ground (apparatus propulsion)	0.0	0.3 (±N/A)	0.0	0.0 (±N/A)
Ground (balance/control)	99.6 (±87.2)	299.2 (±117.8)	179.5 (±41.8)	177.5 (±87.7)
Manipulation	0.0	9 (±N/A)	4 (±31.1)	2.9 (±24.1)
Character	3.8 (±N/A)	0.0	0.0	19 (±N/A)
Strength Training	38.2 (±45.6)	6.7 (±5.7)	59.1 (±62.4)	46.6 (±55.8)
Weekly sessions/participant				
All	6.5 (±1.3)	13.7 (±2.9)	10.4 (±2.1)	9.9 (±2.1)
Aerial	1.8 (±1)	2.9 (±2.9)	3.3 (±3.6)	2.9 (±3.1)
Aerial with ground elements	0.0	1.5 (±0.4)	2 (±1.7)	1.8 (±1.4)
Ground (human propulsion)	2 (±1.3)	5 (±2.3)	1.8 (±0.9)	2.3 (±1.6)
Ground (apparatus propulsion)	0.0	0.0 (±N/A)	0.0	0.0 (±N/A)
Ground (balance/control)	1.9 (±1.7)	5.8 (±2.3)	3.5 (±0.8)	3.4 (±1.7)
Manipulation	0.0	0.2 (±N/A)	0.5 (±0.6)	0.4 (±0.5)
Character	0.4 (±N/A)	0.0	0.0	0.4 (±N/A)
Strength Training	0.7 (±0.9)	0.1 (±0.1)	1.1 (±1.2)	0.9 (±1.1)

Exposure is reported as mean (SD) number of sessions per training type for each group. Sessions were recorded by individual discipline (eg, if a participant had one training session that included tumbling and Chinese Pole it was counted as one session for each discipline). The 3 participants that dropped out of the study are not included in this data set.

the study, including 3 recurrent injuries. Time loss was not normally distributed with a range of 1 to 185 days and median of 19 days. **Table 4** shows the frequency of injury types for the entire cohort and by circus discipline subgroup. Overuse and traumatic injuries were similarly distributed in all groups, except for the ground group that had twice as many overuse as traumatic injuries. The highest frequency of injuries occurred in the shoulder/arm, followed by wrist/hand for the entire cohort (21.3%, 17%) and mixed subgroup (14.9%, 12.8%). Almost half of all injuries were to a joint (46.8%). Muscle and tendon injuries were the most frequent type in the aerial subgroup and second most frequent in all other groups.

When analyzing specific circus activity associated with the injury, 25 injuries (53.2%) were related to doing ground acrobatics, 18 (38.3%) to aerial acrobatics, while the remaining 4 injuries (8.5%) were related to stretching, tripping on mats, and pulling safety lines to support another artist's weight. Of the aerial-related injuries, 6/18 (33%) occurred on an aerial apparatus with ground elements. For ground-related injuries, 15/25 (60%) were related to ground disciplines within the balance/control subgroup, 9/25 (36%) to human propulsion and 1/25 (4%) to apparatus propulsion ground subgroups. Of note, 3/5 (60%) of the injuries in the aerial primary discipline subgroup involved participation in a ground discipline and 3/15 (20%) of injuries in the ground primary subgroup involved an aerial discipline.

DISCUSSION

This prospective pilot cohort study described injury frequency and characteristics related to participation in specific circus disciplines. A novel acrobatic circus discipline classification was introduced with the intent to define subgroups of circus disciplines in which the artists incur similar physical demands so as to determine injury patterns that can inform injury prevention strategies. The study participants were grouped by primary discipline(s) based on their training in the 6 months prior to the study. In the aerial subgroup, their training volume was actually higher for ground than aerial disciplines during the study period showing that their circus participation changed during the study. This demonstrates the complexity of classifying circus artists as training patterns can be influenced by a variety of factors including disciplines that are available to train in a particular facility, show casting, opportunities in a training program, or general market demands.

Another layer of complexity is the variability in the physical stresses related to a single discipline, where one circus artist may primarily perform flexibility-based movements, and another might perform more dynamic, power movements. Some differences in training or performance within a discipline may be due to an artist's physical

Table 4. Frequency (Percentage) of Injury Types by Subgroup of Circus Discipline

	Aerial (n=7)	Ground (n=3)	Mixed (n=14)	Total (n=24)
All	5 (10.6%)	15 (31.9%)	27 (57.4%)	47 (100.0%)
Non-Time Loss	3 (6.4%)	8 (17.0%)	11 (23.4%)	22 (46.8%)
Time Loss	2 (4.3%)	7 (14.9%)	16 (34.0%)	25 (53.2%)
Overuse	2 (4.3%)	10 (21.3%)	14 (29.8%)	26 (55.3%)
Traumatic	3 (6.4%)	5 (10.6%)	13 (27.7%)	21 (44.7%)
Ankle/Foot	0	2 (4.3%)	4 (8.5%)	6 (12.8%)
Knee/Leg	2 (4.3%)	1 (2.1%)	1 (2.1%)	4 (8.5%)
Hip/Thigh	0	3 (6.4%)	3 (6.4%)	6 (12.8%)
Lower Trunk/Pelvis	1 (2.1%)	1 (2.1%)	1 (2.1%)	3 (5.4%)
Upper Trunk	0	3 (6.4%)	2 (4.3%)	5 (10.6%)
Head/Neck	0	0	3 (6.4%)	3 (6.4%)
Shoulder/Arm	2 (4.3%)	1 (2.1%)	7 (14.9%)	10 (21.3%)
Elbow/forearm	0	2 (4.3%)	0	2 (4.3%)
Wrist/Hand	0	2 (4.3%)	6 (12.8%)	8 (17.0%)
Bone	1 (2.1%)	0	2 (4.3%)	3 (6.4%)
Central Nervous System	0	0	1 (2.1%)	1 (2.1%)
Integument	0	0	1 (2.1%)	1 (2.1%)
Joint	1 (2.1%)	7 (14.9%)	14 (29.8%)	22 (46.8%)
Ligament	0	0	1 (2.1%)	1 (2.1%)
Muscle/Tendon	3 (6.4%)	5 (10.6%)	4 (8.5%)	12 (25.5%)
Nerve	0	3 (6.4%)	4 (8.5%)	7 (14.9%)
Stretching	0	0	2 (4.3%)	2 (4.3%)
Contortion	1 (2.1%)	1 (2.1%)	2 (4.3%)	4 (8.5%)
Hand balancing	0	1 (2.1%)	4 (8.5%)	5 (10.6%)
Partner acrobatics	0	5 (10.6%)	1 (2.1%)	6 (12.8%)
Tumbling	2 (4.3%)	0	4 (8.5%)	6 (12.8%)
Trampoline	0	1 (2.1%)	0	1 (2.1%)
Dance	0	3 (6.4%)	0	3 (6.4%)
Rope	0	0	5 (10.6%)	5 (10.6%)
Silks	0	1 (2.1%)	3 (6.4%)	4 (8.5%)
Straps	0	0	1 (2.1%)	1 (2.1%)
Trapeze	1 (2.1%)	0	1 (2.1%)	2 (4.3%)
Chinese pole	0	1 (2.1%)	3 (6.4%)	4 (8.5%)
Aerial bar apparatus	1 (2.1%)	1 (2.1%)	0	2 (4.3%)
Trip on mats	0	1 (2.1%)	0	1 (2.1%)
Pulling lines	0	0	1 (2.1%)	1 (2.1%)

characteristics like flexibility or strength, choreographic style, or artistic direction. In order to accurately capture injury patterns in related circus disciplines, it will be important for future research to track discipline specific exposure as well as the specific mechanisms involved with injuries. The acrobatic circus discipline classification will be useful for comparing and combining this information across injury surveillance studies.

Total weekly exposure and injury rate was highest in the ground subgroup (13.7 ± 2.9, 7/1,000 sessions). This group also had twice as many overuse versus traumatic injuries, different than the others that had more equal distribution. The ground subgroup also had the lowest participation in strength training. A higher workload with less strength capacity could contribute to the higher injury rate and proportion of overuse injuries. This was also the smallest subgroup (n=3) and predominantly male (66.7%), so these findings might be different in a larger group with a more even sex distribution.

Across all subgroups in this study, ground acrobatics was the most common mechanism of injury, accounting for 53.2% of all injuries. Similar patterns have been found in other circus and gymnastics studies.[8,10,18,21] Fifty percent of injuries were related to ground acrobatics in the Wanke et al[17] study of circus students, where overall circus training exposure but not exposure to specific disciplines was reported. Munro[18] reported acrobatics/tumbling as the most common cause of injury in circus students at the Australian National Institute of Circus Arts, where more time in the curriculum was allocated to training these disciplines. Due to limited information on discipline specific exposure across studies, it is unclear if the higher injury frequency associated with ground acrobatics is due to higher exposure or to discipline specific physical stresses, such as impact forces. Consistent methods for tracking discipline specific exposure and classifying circus disciplines in future research may differentiate the effect of overall workload and discipline specific physical stresses.

Across the entire cohort, upper extremity injuries were most common (48.9%) differing from other circus studies[16,17] where lower extremity injuries were most common. The proportion of lower extremity injuries was similar however, 34.0% in this study compared to 35-36% in the others.[16-17] The size, age, and skill level of this study population (n=24, pre-professionals and professionals ages 13-37) compared to Wanke et al[17] (n=169, circus students ages 11-22) and Shrier et al[16] (n=1107 professional acrobats) may contribute to some differences in injury patterns. The context of participation by circus discipline could be another factor, but exposure by specific circus discipline was not reported in these studies. With the diversity in circus disciplines and multidisciplinary nature of artist participation, more detailed reporting on artist participation is needed to effectively compare circus injury studies.

One trend that emerged was an apparent relationship between disordered eating/amenorrhea and higher injury rates. This finding is consistent with other sports.[39-41] In addition, aesthetic sports are associated with a higher risk of low energy availability or inadequate energy for normal physiologic function.[40] Clinicians working with circus artists should include screening for signs of low energy availability such as amenorrhea, decreased performance, irritability, depression and bone stress injuries.[40]

The overall cohort injury rate including TL and NTL was 5/1000 session exposures, lower than for female college gymnasts (9.22/1000 athletic exposures).[8] Since both activities involve ground and aerial acrobatics, the difference in injury rates could be influenced by the broader age range in the circus cohort.[32] Differences in injury definitions (TL/NTL vs medical attention) and exposure measures (sessions vs performances vs time) between the adapted IADMS guideline[22] used in this study and other circus injury studies,[16-20] does not allow for valid comparison of injury rates in circus. This variability in injury reporting highlights the need for a consensus in circus injury research methodology as has been developed in dance and other sports.[22,34-38]

Limitations

The small sample size in this study was underpowered and therefore may limit the generalizability of the study findings to the larger circus population, the ability to use inferential statistics to compare the different subgroups, or determine relationships between the medical history or baseline physical examinations findings and injury patterns. There was a low number of male participants in the study cohort although it was reflective of the study population. The study did not include a mechanism to capture when breaks in training were due to vacation, illness, or non-circus related injuries. This led to some challenges in interpreting the fluctuations in training across the year.

CONCLUSION

This pilot study found more injuries associated with ground acrobatics participation, the upper extremity and joints suggesting the need to focus on these areas for injury prevention in circus. The introduction of a novel classification of acrobatic circus disciplines and the adaptation of the IADMS Standards Measures Consensus[22,32] for circus helped to refine methodology for injury surveillance and structure analysis for the larger cohort study that followed. Circus professionals need to recognize the unique demands of the circus arts and move beyond relying on other sports or performing arts research to guide the coaching and health care for circus artists. In order to build the body of knowledge around circus injuries and compare studies, the circus research community needs to develop common injury surveillance methodology including a consistent way to report exposure and mechanism of injury by circus discipline. A circus specific guideline is essential to understanding injury patterns in the complex world of circus, successfully implementing injury prevention interventions, and evaluating outcomes.

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Reliability of the gymSAFE Movement Screen to Predict Health and Biomechanical Faults in Female Gymnasts

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ABSTRACT

Background: Women's gymnastics ranks second highest in collegiate sports for injuries. The gymSAFE Movement Screen (GMS) is the first screening application to identify areas associated with mechanisms of injury in gymnastics. Purpose: Investigate reliability of GMS scores between two physical therapists who varied in experience with gymnastics. **Methods:** 25 female gymnasts, between 5-16 years of age, were screened by two physical therapists. Percent agreement and intraclass correlation coefficients (ICCs) of scores were analyzed. **Findings:** ICC for total scores was .71 (95% CI (p<.002) for the first measurement and 0.51 (p <.043) for the second. Percent agreement fundamental gymnastic movements items ranged from 42.4% to 77.6%, and 84.6% to 92.3% for the strength and flexibility items. **Clinical Relevance:** A universal screen can assist in interdisciplinary care for female gymnasts. **Conclusions:** Overall, the physical therapists were strongly comparable especially in areas of strength and flexibility. Training for concordance appears necessary for fundamental gymnastics movement subscale because agreement was more variable.

Key Words: application, assessment, prevention, risk score

BACKGROUND

Certain sports are found to have higher severe injury rates, as well as specific musculoskeletal injuries common to that sport.[1,2] Women's gymnastics ranks second highest in National Collegiate Athletics Association sports for severe injuries (defined as acute in nature, happen during competition or practice, require immediate medical attention, and result in at least 3 weeks break from participation or a premature end to their season).[1] In addition to the high severe injury rates, female gymnasts also have high non-traumatic injury rates such as "any damaged body part that interferes with training" and repetitive stress injuries.[2] It has been found female gymnasts train 71% of the time with an injury,[2] often with 45% of these injuries lingering at 38.5 months follow-up.[3] Developing a way to prevent the high injury rates experienced by female gymnasts is a priority to families, coaches, and the providers who care for them.

Similar to developing sport specific training programs for optimal performance, developing sport specific injury prevention screens can potentially assist coaches and providers in the prevention and treatment of musculoskeletal injuries common to that sport. While the Functional Movement Screen (FMS) and Selective Functional Movement Assessment (SFMA) have both been used to help identify areas prone to injury in various sports[4–8], neither are sport specific and vary in their accuracy in predicting injury risk.[4–8] A sport specific screening tool that is valid and reliable could potentially reduce the rates of common injuries experienced in gymnastics, and improve the ability of athletes to train and compete without symptoms.

The Gym Specific Acrobatic Functional Evaluation (gymSAFE) Movement Screen is the first assessment tool to specifically focus on identifying and addressing key common movement faults associated with mechanisms of injury in gymnastics. Using an application (app) to input the movement screen scores, the app summarizes the data and provides a "needs attention at risk" score of each body part. The score is provided to the gymnasts, parents, and coaches to help tailor the gymnasts' training program to prevent injury to the proposed "needs attention" body part. In addition, the gymnast has a quantifiable score that is described in a universal language of strength, range of motion, and foundational movements that all healthcare providers, even those who are not familiar with gymnasts, can understand. This provides efficiency and a cohesive treatment plan among all the providers for the gymnast. Once the score has been reviewed, the gymnasts are taught a gymnastics-specific exercise program designed by a physical therapist with a deep understanding of the needs of the sport.

Another screening tool that is specific to gymnastics is the Gymnastics Functional Measurement Tool (GFMT). This screen focuses on overall fitness (power, speed, flexibility, strength, muscular endurance, and balance) of the gymnast and provides insight to the gymnasts overall total physical fitness and physical state.[9] The gymSAFE Movement Screen provides additional gymnastics-specific information by specifically identifying a competitive female athlete's individual area(s) movement faults that may make them prone to injury. Additionally, the gymSAFE Movement screen is followed by a treatment plan post screen. The gymSAFE Screen is tailored to address the most commonly injured areas of the body in female gymnasts: the foot, ankle, knee, shoulder, and back.[10,11] The purpose of this study is to determine the reliability between a physical therapist who is trained in gymnastics and a physical therapist who is not in administering the gymSAFE screen.

METHODS

Participants

The study was approved through the Notre Dame de Namur University and University of the Pacific Institutional Review Boards. Signed informed consent and assent was provided by each parent and participant, respectively, prior to participating in the study. Study participants needed to be between the ages of 5 and 18 years of age, currently practice with a competitive gymnastics team, and speak and understand English. While the gymSAFE screen was designed with female gymnasts in mind, male gymnasts were not excluded in participating. All participants volunteered and could stop participation at any time during the study. Participants were able to opt out of any assessment that they think would cause pain.

Recruiting for the study took place at local gyms by flyers and on social media sites. Coaches were asked if they were interested in having their gymnasts assessed for injuries using the gymSAFE Screen. If the coaches said yes, then each participant and their parents were asked if they would like to participate in the study. Once consent and assent were received, the parent was emailed the gymSAFE questionnaires regarding the child's years of experience in gymnastics, history of injuries, and the dates and locations of the screening sessions.

Tests and measures

The gymSAFE screen is a 15 min screen designed to be a concise, yet thorough examination of competitive gymnasts' musculoskeletal at-risk areas. The screen includes 3 major categories the gymnasts are assessed in: Flexibility/Range of Motion, Strength, and Fundamental Gymnastics Movements (FGMs) (**Table 1**).

Table 1. gymSAFE Assessment Categories and Tests

Flexibility/Range of Motion
Elbow hyperextension
Knee hyperextension
Knee to wall
Modified Thomas
Wrists
Prone knee bend
Supine SLR
Shoulder ER
Shoulder IR
Strength
Rotator Cuff ER
Rotator Cuff IR
Biceps
Triceps
Interscapular
Quadriceps
Hamstrings
Gluteus Maximus
Gastrocnemius
Abs Leg Lowering
Fundamental Gymnastics Movements
Single leg hop right
Single leg hop left
Plank and reach arms
Plank and lift legs
Drop jump right
Drop jump left
Back bend
Tall kneeling

Abbreviation: SLR, straight leg raise; ER, external rotation; IR, internal rotation

Within the 3 major categories certain fundamental skills used in gymnastics are tested including balance, mobility of joints, manual muscle testing, flexibility testing, and sport specific functional tests. The battery of clinical and sport-specific tests for each category were designed by a gymnastics sport specific physical therapist and gymnastics coach; each with over 10 years' experience in the field. Using a password protected, cloud based, SaaS delivery model, computerized web application assessors enter the data as the participants are tested. An immediate report is then printed that summarizes the score the participant achieved in each of the areas of flexibility, strength, and movement. The report also includes a customized evaluation and recommended next steps from the assessor.

The gymSAFE application uses 3 subscales for assessment: flexibility, strength, and FGM. For the Flexibility and Strength score, assessors list either 2=Strong, 1=Weak, or 0= needs attention. For the FGM score, movements assessing balance, stability, and control are assessed with the assessors providing a score by checking or unchecking the box for whether the gymnast meets the desired form (**Figure 1**). The application then provides a summed score for each category of flexibility, strength, and fundamental gymnastic movements (FGM) as well as an overall score.

Figure 1. Sample Assessment of Functional Gymnastics Movements Single Leg Hop Right and Left

Single Leg Hop (Right)
- ✓ Stays within borders of box
- ✓ Foot-knee-hip alignment maintained
- ✓ Lands with good arch control
- ✓ Both hands stay on waist
- ✓ Pushes off foot
- ✓ Lands quietly (non stiff landing)
- ✓ Holds 5 seconds

Single Leg Hop (Left)
- ✓ Stays within borders of box
- ✓ Foot-knee-hip alignment maintained
- ✓ Lands with good arch control
- ✓ Both hands stay on waist
- ✓ Pushes off foot
- ✓ Lands quietly (non stiff landing)
- ✓ Holds 5 seconds

Study procedure

The study procedure began with concordance training between the 2 gymSAFE assessors. Two physical therapists assessed the gymnasts using the gymSAFE Screen. One of the physical therapists administering the screen was a gymSAFE staff member and the other was not. In the months prior to the study screening session the gymSAFE staff member trained the additional assessor how to perform the screen. Training consisted of the trainee reading the handbook of the screening components, watching the training videos of each test, meeting with the gymSAFE staff for hands on review of each test, practice assessing local volunteer gymnasts (**Figure 2**), and use of the application in real time; in total training took 4 hours.

Two screening sessions took place over 2 days. Each day of the study consisted of the 2 assessing physical therapists screening each gymnast 2 times, with a 30-minute break between each testing session. Before testing, the gymnasts were handed an iPad to watch and listen to the instructions on how to perform each of the FGMs. The gymnasts then performed the movement while the assessors evaluated the movement. Participants could opt out of any movement they felt would produce pain. After each screen, scores were computed. The following day, participants received their scores and the researcher, who was affiliated with gymSAFE, reviewed the gymSAFE screen report with the participant, parent/guardian, and to their coach for training purposes. After the explanation of the report, the participants were given their exercise prescription and taught an exercise program, led by a physical therapist of the gymSAFE staff.

Data analysis

Primary analyses were limited to the female gymnast participants (n=25); as the gymSAFE screen was developed for evaluating female gymnasts' flexibility, strength, and FGMs. Percent agreement was used to describe the physical therapists comparability in assessment using the gymSAFE Screen. All data from the score sheets were pooled to compare the first assessor to the second using intraclass correlation coefficients (ICCs) and 95% confidence intervals. Statistical analyses were carried out using STATA 10 software (StataCorp LP, College Station, TX).

FINDINGS

Twenty-six (n=25 females) gymnasts

Figure 2. gymSAFE Assessment

participated in the study. The average age of the participating female gymnasts ranged between 5 and 16 years of age (average: 11.75 years), with a range of gymnastics levels. Percent agreements in flexibility/range of motion, strength, and FGMs portions of the screen, ranged from 50% to 96.1% (flexibility), 42.3% to 96.2% (strength), and 59% to 90.7% in the fundamental gymnastics movement category (**Tables 2-4**).

Percent agreements in "usual" physical therapy (meaning non-gymnastics specific physical therapy) flexibility/ROM, such as assessing knee hyperextension, shoulder internal/external rotation; the percent agreements ranged between 84.3% and 96.1%. In the "usual" physical therapy strength measures, such as assessing rotator cuff and tricep strength; percent agreements ranged between 84.6% and 92.3%. Whereas in the gymnastics specific flexibility/range of motion and strength measures, such as assessing abdominal strength by 2 leg lowering-a movement that most non-gymnasts do not perform daily; the physical therapists had lower agreements. Even so, by the second trial the percent agreement in such gymnastics specific flexibility/range of motion and strength scores increased by 31.7%.

Overall, the smallest difference between the physical therapist assessors in scoring were seen in the flexibility and strength categories (**Tables 2 and 3**). For example, in assessing left knee hyperextension at time 1 and 2, the physical therapists were 92.3% and 94% comparable (**Table 2**). In their assessment of left interscapular strength at time 1 and time 2, the physical therapists were 92.3% and 90.2% comparable (**Table 3**). In assessing right quadriceps strength at time 1 and time 2 the physical therapists were 96.2% and 90.2% comparable (**Table 3**). For the majority, the largest difference between the physical therapists were assessment in the FGMs. In the single leg hop (right) at time 1 and time 2, the physical therapists were 76.9% and 59% comparable (**Table 4**). However, within the tasks such as the plank and lift legs the assessors compared 90.7% at trial 2 (**Table 4**).

The ICC for comparing overall total scores between the two physical therapists for the first screen was .71 (95% CI [0.4,0.9]); $p<.002$ (**Table 5**). The ICC for the second screen was 0.51 (95% CI [-0.1,0.8]); $p <.04$ (**Table 5**).

Table 2. Percent Agreement Between the 2 Physical Therapists Scoring the gymSAFE Screen of Flexibility/Range of Motion

	Percent agreement between physical therapists for trial 1		Percent agreement between physical therapists for trial 2	
	Right	Left	Right	Left
Elbow hyperextension	64	60	77.6	76
Knee hyperextension	73.1	92.3	90	94
Knee to wall	69.2	76.9	79.5	88
Modified Thomas	73.1	50	68.6	68.6
Wrists	88.5	76.9	84.3	80.4
Prone knee bend	58.3	57.7	77.6	68.6
Supine SLR	50	65.4	70.6	64.7
Shoulder ER	76.9	73.1	94	86.3
Shoulder IR	76.9	80.8	84.3	96.1

Abbreviations: SLR, straight leg raise, ER, external rotation; IR, internal rotation

Table 3. Percent Agreement Between the 2 Physical Therapists Scoring the gymSAFE Screen of Strength

	Percent agreement between physical therapists for trial 1		Percent agreement between physical therapists for trial 2	
	Right	Left	Right	Left
Rotator Cuff ER	88.5	84.6	86.3	80.4
Rotator Cuff IR	88.5	76.	92.2	86.3
Biceps	76.9	76.9	88.2	82.4
Triceps	92.3	88.5	94.1	90.2
Interscapular	92	92.3	95.9	90.2
Quadriceps	96.2	94.6	90.2	92.2
Hamstrngs	90.8	65.4	78.4	74.5
Glluteus Maximus	50	76.9	68.6	68.6
Gastrocnemius	60	66.7	76.6	94.4
Leg Lowering	42.3		74	

Abbreviations: ER, external rotation; IR, internal rotation

CLINICAL RELEVANCE

Overall, the two physical therapists had strong agreement in their total gymSAFE screen scores. It was interesting to note that while the reliability between the physical therapists ranged and decreased at the second screen (to "moderate" vs "good" at screen one), overall, their percent agreements

Table 4. Percent Agreement Between the 2 Physical Therapists Scoring the gymSAFE Screen of Fundamental Gymnastics Movements

	Percent agreement between physical therapists for trial 1	Percent agreement between physical therapists for trial 2
Single leg hop right	76.9	59
Single leg hop left	72.5	66.7
Plank and reach arms	69.3	74.1
Plank and lift arms	69.9	90.7
Drop jump right	75.4	75.9
Drop jump left	71.5	68.5
Back bend	82.9	88.9
Tall kneeling	84.6	75.9

Table 5. Intraclass Correlation Coefficients Between Assessors at Screen 1 and Screen 2, with 95% CI

1st Screen Average ICC (95% CI)	2nd Screen Average ICC (95% CI)
0.70 (95% CI, 0.4, 0.9)	0.51 (95% CI -0.1, 0.8)
p<0.002	p< 0.043

increased. The two categories the physical therapists were most comparable in were the Flexibility and Strength categories and were less comparable in the FGMs. The gymSAFE Screen uses common strength and flexibility measures that all physical therapists are trained in; whereas the FGMs were specifically chosen for their basis in gymnastics, which many physical therapists may be unfamiliar with. In addition, even within the "usual" physical therapist measures of Flexibility and Strength-while some of the components are common to physical therapy knowledge (prone knee bend), the difference lies in what a prone knee bend looks like in a gymnast vs in a non-gymnast, and how this is assessed by the gymSAFE protocol; leaving room for differences in assessment. Another example of this difference is in how one physical therapist trained in orthopedics assesses abdominal strength can vary compared to how another physical therapist trained in gymnastics assesses abdominal strength; in particular, what qualifies as an indicator of "weakness" vs "strength" (example: Sahrmann Movement Screen vs Manual Muscle Testing). In the non-gymnastics patient population, the orthopedic physical therapists do not perform the gymnastics specific type of flexibility and strength exams or interventions. Therefore, making it less likely non-gymnastics orthopedic physical therapist would be familiar with the level of flexibility and strength seen in the gymnastics population. Thus, it is important that physical therapists are trained in each assessment of the gymSAFE screen, and understand the specific movements, to score the movements based on the gymSAFE classification, should they encounter gymnastic patients in their practice.

Limitations to this study include a small sample size of both patients and therapists. While the ranges in age and competitive level of the gymnasts provided good information on the overall reliability of the gymSAFE screen it is of interest to have larger sample sizes to determine reliability among specific age groups, competitive levels, and even specific gyms and teams. It is recommended that lead physical therapists, those trained in the gymSAFE screen, perform screenings and a consensus is achieved. From a recruitment perspective, due to the traveling schedule of the teams and that teams practice up to 20 hours a week, it was challenging to set up the assessment schedule. This meant participating in the screen required time for the gymnast to be away from practice. Future recruitment strategies can include the possibility of "whole team" recruitment or "whole gym" recruitment to minimize disruption in the practice schedule. It is of interest to have further reliability studies with coaches and other healthcare providers (medical doctors, athletic trainers, physician assistants, etc) which could assist with recruitment.

The gymSAFE screening application provides a sport specific screening tool that translates a gymnast's flexibility, strength, and overall sport specific functional movement information across disciplines. By efficiently and effectively translating this information; the care provided to female gymnasts is more complete amongst providers, coaches, and parents/guardians.

With reports of almost half of adolescent female gymnasts experiencing back pain[12] and overall high injury levels among all competitive levels, and rising medical costs; there is a call for consistent reporting methods.[13] This study demonstrates the gymSAFE application is reliable among two physical therapists, despite experience with gymnastics. The potential for reporting reliable and transferable information via gymSAFE application for both research and clinical care is of high value for the gymnastics field.

CONCLUSIONS

Overall, the physical therapists were strongly comparable in their gymSAFE scoring; especially in the areas of strength and flexibility. It is recommended that physical therapists interested in using the GMS, especially those not trained in gymnastics, be trained in how to assess; particularly in the fundamental gymnastics' movement category. Having a universal screen among providers can assist in better interdisciplinary care for our female gymnasts.

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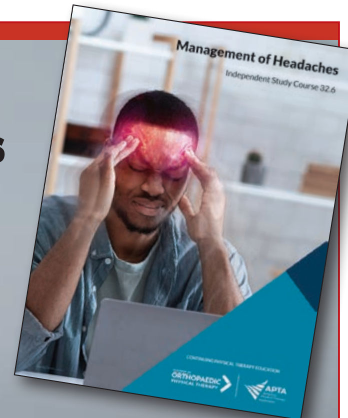

Stress and Anxiety: Drivers of Poor Workers' Compensation Outcomes

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INTRODUCTION

For physical therapists and other healthcare professionals working with the workers' compensation population, it is well known that patients being provided care through this model generally take longer to return to work, and return to their preinjury levels of employment at an overall lower rate,[1] when compared to other patient demographics. A common assumption is that secondary gain issues are the primary driver for these poor results. While this is a factor that needs to be considered, there are also many other elements that can drive poor outcomes. These additional considerations must be understood by all stakeholders, as they may impact the successful management of workers' compensation patients. By educating healthcare providers, payers, and employers on potential complicating factors, strategies to mitigate their effects can be implemented by all, and therefore allow us to best serve this patient population.

As injured workers can be a particularly vulnerable patient population, these risk factors should be identified and addressed early when managing their care. Some of these factors are modifiable and others are not. Low educational level, poor job satisfaction, and negative financial impact have all been linked as contributors to poorer outcomes.[2] While these are variables that healthcare providers cannot necessarily influence, it is important to be aware of common risks that negatively influence return to work outcomes in the workers' compensation patient population. For example, one study found that 54% of injured workers whose main income was workers' compensation were experiencing substantial financial stress.[3] This source of stress to an injured worker is harmful to their rehabilitation and return-to-work prospects.

While these variables should be understood by healthcare providers, the focus of today's discussion will address modifiable factors. For example, there is an abundance of data making practical recommendations in regards to nutrition and hydration being able to help reduce surgical complications, minimize muscle loss during periods of immobilization, and maximize return to function.[4] Additionally, getting the appropriate amount of sleep is also a widely overlooked and a valuable component of proper healing.[5] Finally, addressing mental health and wellness (particularly by managing stress and anxiety) has been shown to improve outcomes while reducing the overall cost of the medical claim.[6]

STRESS AND ANXIETY – THE PHYSIOLOGIC IMPACT TO THE INJURED WORKER

Stress and anxiety are often perceived as a mental health condition. While it is true that this experience is brain driven, it is important to understand that what the brain perceives as "real", in this case a stressful experience, results in physical sequelae. By understanding the body's physiologic responses to stress, the healthcare provider can educate their patients, particularly injured workers (as this group is more prone to a stressful rehabilitation process[7]) and therefore allow them to better manage the negative consequences. Stress impacts multiple body systems, and does so in a fashion that ultimately delays healing. Systems impacted include the sympathetic nervous system, endocrine system, immune system, and musculoskeletal systems. The sympathetic nervous system, or our "fight or flight system," responds strongly to our thoughts, beliefs, perceptions, moods, and memories.[8] Stress stimulates the sympathetic nervous system response that responds by releasing adrenaline. This adrenaline release, while not capable of causing pain independently, can promote a sensitized state within healing tissue, and therefore facilitate ongoing pain.[9]

To complicate matters further, sustained stimulation of the sympathetic nervous system is also going to negatively impact sleep, tissue healing rates, and digestion, all of which can delay functional improvements. The facilitation of the sympathetic nervous system also promotes activation of larger, torque producing muscles in our body while inhibiting smaller, stabilizer muscles. By doing so, even the musculoskeletal system is impacted by stress. This can be problematic as these smaller stabilizer muscles are often critical to activating and retraining as part of a recovery program.

Stress can also influence the endocrine system, causing the release of adrenocorticotropic hormone from the pituitary gland. Adrenocorticotropic hormone prompts the release of cortisol from the adrenal gland. Cortisol works in our body as a protective mechanism, activating some systems, while slowing others not integral for survival. Tissue healing is one such process that is slowed, or put on hold altogether, when cortisol is released into the bloodstream. In addition to slowing tissue healing, cortisol has also been demonstrated to facilitate poorer quality of healing, loss of memory, depression, despair, and a decline in physical performance.[8]

Finally, the body's chemical response to stress (adrenaline and cortisol) also has an impact on the immune system, spurring the release of pro-inflammatory cytokines that can negatively impact healing. Furthermore, these cytokines promote an inflammatory state, which can facilitate increases in pain (as peripheral nerves can be particularly reactive to proinflammatory cytokines[8]). In summary, stress can create a negative physiologic impact on multiple systems of our bodies. This can negatively impact the healing process following an injury, and subsequently delay return to work. Employers, payers, and healthcare practitioners should be doing everything within their power to reduce stress in injured workers as this will facilitate a timely recovery and improved tissue healing.

FIRST LINE OF DEFENSE – EMPLOYER EMPATHY

So, what can be done by employers to mitigate some of the factors that contribute to the anxiety and stress of injured workers? Step one should be to practice empathy. Employers that do this, and put their employees first in terms of priorities, gain trust and confidence from their team. This results in greater employee engagement and motivation, and has been shown to decrease overall costs associated with an injury.[6] Timeliness are also very important. Engaging the injured worker early boosts resilience that can help improve recovery while reducing costs associated with the claim.[7] Employers must learn about the unique concerns of each individual injured worker. By doing this, they can address misconceptions, provide guidance on next steps, ensure the employee has a point of contact for questions, and set expectations as the injured worker moves through the workers' compensation system. Evidence has shown that positive outcomes depend highly on the company's value system, as in whether the company views the injured worker more as an asset or a liability. Making the injured worker feel like they are an important part of the organization and they are being supported has been demonstrated to have a positive impact on outcomes.[10]

Unfortunately, this "employee first" approach is not ubiquitous among employers/payers, and it has negative consequences. In a 2015 article in the *Journal of Occupational Rehabilitation*, Kilgour et al concluded that "involvement in compensation systems contribute to poorer outcomes for claimants. Interactions between insurers and injured workers were interwoven in cyclical and pathogenic relationships, which influence the development of secondary injury in the form of psychosocial consequences instead of fostering recovery of injured workers."[11(p160)]

This Kilgour research article referenced above highlights that by simply being involved in the workers compensation system, and that by interacting with stakeholders, typically in the hopes of facilitating claims resolution, that outcomes are being negatively impacted. Imagine if this were true in the therapy realm; ie, patients referred for therapy services demonstrated worse outcomes than non-therapy counterparts. It is likely referrals would stop, as payers would note the lack of value in the services provided. Yet, in this case, it is the payer and the employer negatively impacting outcomes, and ultimately, they cannot remove themselves from the equation. So, what can be done? Employers and payers alike must learn to demonstrate empathy to all injured workers, and commit to communication early and frequently throughout the claims process. Additionally, reassurance should be provided that the injured worker is a valuable member of the organization and that helping them heal after injury is important. As discussed in the paragraphs above, employers that adhere to these guidelines have experienced more positive workers' compensation outcomes.

THE ROLE OF THE PHYSICAL THERAPIST

In addition to actions that employers and payers can take to minimize factors leading to stress for injured workers, healthcare professionals can also play an important role. Physical therapists, due to their expertise and the substantial amount of time they spend with patients, are well suited to address multiple risk factors for stress. While exercise can certainly assist in managing stress, physical therapists can also leverage their clinical knowledge to educate injured workers in other strategies to reduce their stress. Educating patients on diagnostic imaging, relaxation techniques, sleep hygiene, and the body's normal healing process can all be crucial to helping the injured worker better understand their injury, as well as decrease stress and anxiety. Please reference **Figure 1** for some "icebreaker" questions to implement in your own clinical practice. These questions, and their subsequent responses, will not only provide insight into the injured worker's mental status, but foster opportunities for education (referencing the content below).

Figure 1. Breaking the Ice - Questions to Initiate Conversations

- What concerns you most about your injury?
- From your point of view, describe your injury to me? What tissue is involved, what do you perceive as the potential outcome, etc.?
- Has your employer been supportive during your recovery?
- Do you understand how the worker's compensation system works? Do you know who to contact with questions?
- Has your injury contributed to additional stress in your life?
- I noticed you mentioned your MRI diagnosis. Has anyone consulted with you regarding the findings?
- While it may sound unconventional, have you ever tried meditation or mindfulness as a way of managing your symptoms?
- Is your injury impacting restful sleep? How much sleep would you estimate you get each night?

Physical Exam Guides Treatment Interventions

When patients are given a grim diagnosis based solely on the results of diagnostic imaging, it can be crippling to the outcome of any musculoskeletal injury, and particularly so in a workers' compensation claim. Evidence has shown that medical imaging should only be performed to confirm a serious pathology after a thorough examination.[12] Unfortunately, this is not always how healthcare providers practice, and as a result many injured workers are given a diagnosis primarily based on the results of diagnostic imaging. How does this approach negatively impact rehabilitation? These "diagnoses" are often mentally anchored within the patient as the source of their pain and dysfunction, and it is often assumed that without direct intervention of these diagnosed structures (discs, degenerative changes, etc.) that symptoms will not improve. This facilitates a biomedical approach to treatment and care, which, as outlined by Beales et al in 2016, is notoriously unhelpful.[13]

In short, taking an image (MRI/X-ray), and then blaming a particular structure as the source of symptoms, often serves to negatively impact rehabilitation from injury. So how can injured workers experience positive outcomes if imaging is not indicated? By performance of a thorough exam. Physical therapists are well trained to perform a thorough exam to establish the actual source of an injured worker's pain. Once identified, therapists can intervene with a variety of treatment options to improve the patient's acute symptoms, facilitate buy-in, and reduce stress.

Context with Medical Imaging Studies

But what happens when an injured worker presents in the clinic for an evaluation and they have already been given a "diagnosis" based on medical imaging? While this can certainly provide a hurdle, therapists can assist by adding perspective, and therefore reducing stress and anxiety. Numerous studies[14,15] have shown a very high prevalence of asymptomatic patients that present with positive findings on diagnostic imaging. Conversely, studies have shown a high prevalence of symptomatic patients with negative imaging findings. The take home message: positive findings do not directly corelate with symptoms. Putting these diagnostic imaging results into perspective can allay many of the fears that the injured worker has on their prognosis, and allow for faster progression toward a positive functional outcome.

Meditation for Stress Management

Another element worth discussing in reference to stress and anxiety is the substantial neural overlap in our brains in regards to where one experiences emotions and physical pain. When patients are in a stressful state, it becomes easier to exacerbate painful conditions or to increase the intensity of pain. Patients with additional psychosocial factors are more likely to develop chronic pain. Chronic pain can further drive the patient's stress and anxiety, creating a vicious pain-stress cycle. Physical therapists can intervene to break this cycle by educating injured workers on meditation. This incredibly simple, yet effective treatment has been demonstrated to improve mood, increase our sense of well-being, and assist with the symptoms associated with anxiety, stress, and depression.[16]

Improving our present state or mindfulness through meditation has been demonstrated to activate or deactivate portions of our brain and cause positive impacts on its' functionality. This happens through a process called neuroplasticity, where the brain can form new neural pathways that can better assist with managing fear, stress, and anxiety while also improving our focus and decision-making. Learning meditation can be an easy process, and not nearly as difficult as many assume. There are numerous resources available, ranging from books, to phone applications, podcasts, and websites. A physical therapist can introduce these resources and educate on the benefits of daily meditation. This can make an impact on an injured workers' functional outcome, even if only performing meditation for as little time as 10 minutes a day.

Sleep – The Unsung Hero

Another often overlooked factor when managing and recovering from an injury is sleep. The National Institute of Health recommends that adults over the age of 18 get, on average, at least 7 to 8 hours of sleep per night. A National Sleep Foundation poll, performed in 2013, showed that more than 65% of the United States population fail to obtain the recommended 7 to 9 hours of sleep each night during the week.[5] Bodies need sleep to reorganize the musculoskeletal and neurophysiologic systems, as well as repair important neural connections in the brain. This can help regulate systems that govern how pain responses are impacted by past experiences like fear, anxiety, and depression. In fact, sleep, particularly Rapid Eye Movement (REM) sleep (which is most prevalent during the end of an 8-hour sleep cycle), can be paralleled to a 'soothing balm' for our emotional state. During REM sleep, concentrations of a key stress-related chemical (noradrenaline) are completely shut off within your brain.

Why is this important? It allows for the "reprocessing of upsetting memory experiences and themes in a neurochemically calm, safe,…brain environment."[5(p208)] This is essential for humans to properly process stressful events, and reduce the visceral, painful emotional element that was previously wrapped around those memories and experiences. Imagine what this means for injured workers who are not sleeping enough. By not getting 8 hours, they are missing out on an opportunity for REM sleep, which allows for an elevated level of a stress chemical in their brain, and this subsequently makes it difficult to remove the emotional stress from the experience. By staying in a neurologically stressful state, this can drive other physiologic responses (previously discussed above), which can further delay healing and increase the probability of a poor outcome.

An understanding of the importance of sleep provides physical therapists and healthcare providers an opportunity to educate injured workers on the benefits of a good night's sleep. By doing so, one can help them manage stress and anxiety, which in turn will help them better manage their pain, and promote improvement in function. One of the most important strategies a physical therapist can recommend to patients is to establish a nightly routine to prepare their body for sleep. This has been shown to enhance the amount and quality of their sleep.[5] Most importantly, this routine should include going to bed (and getting up) at the same time every day. Additional elements of this routine can include reading a book (no iPads or phones), taking a warm shower, meditation, and oral hygiene. Computer or phone screens should be eliminated at a minimum of 30 minutes prior to going to sleep, as the light emitted from these screens activates portions of the brain associated with wakefulness, and delays release of melatonin.[5]

Additionally, nutritional and dietary consumption should be considered when trying to promote improved sleep. All caffeine should be avoided after noon, and fatty and sugary foods should be avoided right before bed. Furthermore, alcohol should be avoided completely. While drinking alcohol may make one feel sedated and help to fall asleep, it negatively impacts the quality of one's sleep, most often by fragmenting sleep and by suppressing the ever-important REM sleep (mentioned above). Finally, ensuring that one's environment is suitable to promote proper sleep is crucial. This includes reducing light and noise prior to going to bed, keeping the room dark, and maintaining a slightly lower temperature than normal (experts recommend 65 degrees). This will keep our body's core temperature at a lower level, which is essential to falling asleep and maintaining restful sleep.[5]

Reassurance – Hurt vs. Harm and Tissue Healing

In addition to education on diagnostic imaging, meditation, and sleep, therapists and healthcare providers can provide assurance to the injured worker that one's bodies have an unbelievable ability to heal naturally. As mentioned above in the diagnostic imaging paragraphs, many common diagnoses possess words like "degenerative," or "torn muscle." These words can elicit a response from the injured worker that makes them wonder if they will ever heal from their injury. The fact is, for most musculoskeletal conditions, complete healthy tissue healing time ranges from as little as 6 weeks to 6 months after an injury (depending on the type of tissue injured and the type of collagen needed to repair). As the patient's tissue heals, any pain that persists beyond tissue healing time is likely more associated with central (brain) protective responses, and less derived from local tissue (nociceptors).

Considering what we have just discussed about stress and anxiety, and the physiologic and psychological responses that accompanies it, an injured worker in a stressful state can find themselves falling victim to this centrally driven genesis of pain. This is why it is so important to educate our patients on our body's natural ability to heal, along with explaining topics like pain neuroscience to add context to their symptoms and persistent pain. By educating the injured worker, we can demystify the origins of their symptoms, and place the injured worker in a position to better manage their symptoms. Placing the injured worker in control of symptoms not only increases the probability of functional progression, but also decreases their sense of stress and anxiety.

SUMMARY

To briefly summarize, injured workers fare worse than their non-workers' compensation counterparts. There are a variety of reasons for this, some of which are not modifiable. However, there are strategies that can be implemented by payers and employers to reduce stress. Additionally, healthcare providers, in conjunction with providing patients with evidence-based treatments, can provide education on a variety of topics, all of which are suited to reduce the stress and anxiety associated with a work-related injury. By doing so, all stakeholders can improve the probability of the injured worker having a positive rehabilitation and claim experience. Why does this matter? Studies have shown that having a positive claims experience is strongly associated with earlier return to work after a work-related injury.[17]

Furthermore, evidence has shown that programs designed to decrease stress levels in injured workers have been effective in their return-to-work rates.[18] Finally, in addition to the costs savings from decreased medical claims and earlier return to work, reducing worker stress has also proven to be effective in reducing turnover and absenteeism while also increasing productivity.6 All of this to say, the evidence supports taking steps to minimize stress and anxiety to the injured worker. By doing so, and by engaging all stakeholders throughout the continuum of care, physical therapists can facilitate better outcomes and reduce costs.

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PRESIDENT'S MESSAGE

Laurel Daniels Abbruzzese, PT, EdD | labbruzzese@orthopt.org

NEW PASIG LEADERS

We want to welcome Danielle Farzanegan, who will be serving as the new Performing Arts Special Interest Group (PASIG) outreach chair and Michael Tsang, our new Research Chair. Both of these leaders need PASIG members to serve on their committees, so please reach out to get involved.

NETWORKING OPPORTUNITIES

I want to remind all of you that one of the benefits of being a member of the PASIG is membership in our closed Facebook Group. We currently have 323 members on that site. Members use this space to share resources, locate providers for artists in different areas of the country, and post continuing education opportunities. That space will be more useful to everyone with increased engagement and posts. Check it out! https://www.facebook.com/groups/1546315278934871/

CITATION BLASTS

Another benefit of your PASIG membership is a monthly citation blast sent to you via email. You also can contribute to the PASIG as an author! We have a call for PASIG Citation Blast authors for the months of August 2022 and beyond, so please consider a written contribution! If you, physical therapy students or fellows, or your physical therapy colleagues may be interested in contributing to another Citation Blast (whether you have already been an author, or if you are interested in writing your first annotated bibliography), feel free to message our Research Chair, Michael Tsang directly on Facebook or at kinghontsang@hotmail.com for more information.

We are more than happy to have students contribute, and an Academy of Orthopaedic Physical Therapy website publication could be a nice addition to your résumé and a great networking opportunity within our performing arts community! Please spread the word and hope to hear from you soon!

The full list of Citation Blasts is on the AOPT PASIG webpage for examples: https://www.orthopt.org/.../perfor.../citations-and-endnotes

PASIG SCHOLARSHIPS

To recognize students for their contribution to performing arts physical therapy and to assist in defraying the cost of attending the Combined Sections Meeting (CSM), the PASIG will support up to two $500 scholarships for one entry-level student and one post-professional student presenting research at CSM.

Eligibility:

1. Must be a student in an accredited pre-professional (DPT) or post-professional Performing Arts Fellowship Program when the research was conducted.
2. Must be a member of the PASIG.
3. Must be listed as an author on the poster/presentation.
4. Must have confirmation of acceptance as either a platform or poster presenter at the upcoming CSM meeting.
5. Topic of research must focus on performing arts physical therapy (and submitted under the Performing Arts subheading within the AOPT).
6. Must participate in presenting the poster/platform at CSM.

PASIG CALL FOR MEDIA!

We are extending our call for media. The PASIG would like to feature our own members in videos being created for various strategic initiatives.

You can scan the QR code to submit entries at: https://cumc.co1.qualtrics.com/jfe/form/SV_6nRQ8IQ5ZKCtDBc

PERFORMING ARTS FELLOWSHIP TRAINING

Physical therapists with an orthopaedic certified specialist, sports certified specialist, or completion of an orthopedic residency may choose from one of four performing arts fellowship programs for advanced training and specialization in performing arts. If you have questions about starting a performing arts fellowship program, contact our chair, Tiffani Marruli, tiffany.marulli@osumc.edu. For specific program questions, contact the program directors.

- **Columbia University Irving Medical Center and West Side Dance Performing Arts Fellowship**
  - Program Director: Laurel Daniels Abbruzzese la110@cumc.columbia.edu
  - https://www.ps.columbia.edu/education/academic-programs/programs-physical-therapy/performing-arts-fellowship
- **NYU Langone-Harkness Center for Dance Injuries Performing Arts Fellowship**
  - Program Director: Angela Stolfi harkness@nyulangone.org
  - https://med.nyu.edu/departments-institutes/orthopedic-surgery/specialty-programs/harkness-center-dance-injuries/education/professional-development-students-healthcare-practitioners/academic-observation-fellowship
- **The Johns Hopkins Hospital Performing Arts Fellowship**
  - Program Director: Andrea Lasner danceFIT@jhmi.edu
  - https://www.hopkinsmedicine.org/physical_medicine_rehabilitation/education_training/therapy-residency/physical-therapy/performing-arts-pt-fellowship.html
- **The Ohio State University Wexner Medical Center Performing Arts Fellowship**
  - Program Director: Tiffany Marulli tiffany.marulli@osumc.edu
  - https://hrs.osu.edu/academics/graduate-programs/clinical-doctorate-in-physical-therapy/residencies-and-fellowships/performing-arts

PASIG PRACTICE PEARLS PODCAST

Our fifth installment of *PASIG Practice Pearls Podcast* series is a two-part series focused on Performing Arts Fellowship opportunities! All episodes are open to the public and are available on the PASIG website.

PERFORMING ARTS -SIG FEATURED CONTENT

If you have a performing arts case study or research study that we can feature in an upcoming issue of *Orthopeadic Physical Therapy Practice*, please bring it to my attention labbruzzese@orthopt.org. We are eager to share the work of performing arts physical therapists and researchers with the broader orthopedic physical therapy community.

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A Free Preview on the Lumbar Spine is available here: https://www.orthopt.org/uploads/content_files/files/Free_Preview_Current_Concepts%281%29.pdf

AOPT's Clinical Practice Guidelines can be accessed here: https://www.orthopt.org/content/practice/clinical-practice-guidelines/published-cpgs

GREETINGS FASIG MEMBERS!

In this issue, we have an important message from Dave Sinacore about why and how we all have an important role in evaluating and directing care in our patients who have diabetes. Please heed the message: your patients will thank you.

Frank

Dem Bones, Dem Bones, Dem Foot Bones: Recognizing the Foot Bone-Kidney Connection

David R. Sinacore PT, PhD, FAPTA
Professor & Director of Research, Department of Physical Therapy, Congdon School of Health Sciences, High Point University, High Point, NC

I am certain most of you are familiar with the spiritual song "Dem Bones." You remember…"Toe bone connected to the foot bone; foot bone connected to the heel bone; heel bone connected to the ankle bone, etc…etc." These lyrics composed by songwriter James Weldon Johnson (1871-1938) were believed to be inspired by the prophet Ezekiel [Ezekiel 37:1-14] when he visits the "Valley of the Dry Bones."[1]

Well, today Ezekiel and songwriter Mr. Johnson would likely describe that *"the foot bone connected to the kidney"*… This connection would be entirely accurate and profoundly prophetic, specifically impacting our patients with diabetes mellitus, peripheral neuropathy, and chronic kidney disease (CKD). Physical therapists and particularly members of the Foot and Ankle Special Interest Group of the Academy of Orthopaedic Physical Therapy should be keen to recognize and understand this important connection, since it has long been recognized that end-stage renal disease is a major risk factor and contributor to non-traumatic lower extremity (foot) amputation in individuals with both phenotypes (ie, type 1 and 2) of diabetes mellitus.[2] When the complications of diabetic peripheral neuropathy combine with progressive diabetic nephropathy (the most common type of CKD), the risk for foot ulceration and lower extremity amputation (LEA) increase dramatically.[3]

Renal osteodystrophy (the older term was renal rickets) occurs in nearly 90% of individuals with diabetes mellitus and CKD with a progressively increasing prevalence in the later stages of CKD (ie, stage 4 and stage 5).[4] Historically and currently, bone histology from bone biopsy of the ilium remains the gold standard method for diagnosing and classifying the type of renal osteodystrophy (ROD). Radiological diagnosis of ROD using dual-energy x-ray absorptiometry (DXA) or quantitative computed tomography to assess the loss of bone mass (bone mineral density [BMD]) in the hip or lumbar spine has become more routine for follow-up in those individuals with established disease.[5] However, as our methods of regional BMD assessments have improved, it is now apparent that foot bones lose both cortical and trabecular bone mass at a rate that may exceed the loss in the hip and lumbar spine.[6,7] In fact, pedal osteolysis may be the incipient biomarker of ROD in the foot resulting in neuropathic fractures, acute Charcot neuroarthropathy and chronic foot deformities leading to sequelae such as plantar ulcerations and osteomyelitis that too often culminate in partial or complete foot amputation.[8]

What is the foot bone-kidney connection?

Like most physiological and metabolic cascades, the bone-kidney axis is highly complex. Despite the complexities of these endocrine interactions, a decreasing functional nephron mass in CKD clearly impairs the kidney's ability to filter metabolic toxins and interferes with the kidney's vital role in regulating the body's serum phosphate and calcium stores. The burden placed on the remaining functioning nephrons to regulate and maintain serum phosphate and calcium levels, stress the bone-kidney axis by triggering the skeleton's osteocytic secretion of several circulating factors including fibroblast growth factor 23 (FGF23) and sclerostin.[9,10] The FGF23 is an osteocyte-derived hormone that regulates phosphate excretion, whereas sclerostin is an important osteocyte-secreting protein (one of the circulating wingless-related integration site [WNT] inhibitor proteins) that inhibits new bone formation and remodeling. In CKD, elevated secretion of sclerostin not only derives from skeletal osteocytes, but also may arise from the smooth muscle cells in the vascular media causing excessive vessel stiffness and difficulty regulating blood flow to the foot. In CKD, high levels of sclerostin are directly associated with vascular and extra-vascular calcification.[10]

What is the link of CKD-MBD to foot bones?

In 2006, the Kidney Disease: Improving Global Outcomes (KDIGO) working group described a new syndrome of Chronic Kidney Disease-Mineral Bone Disorders (CKD-MBD).[11] This evolving syndrome now links progressive renal disease to atherosclerotic cardiovascular disease and mineral-bone disorders resulting in early-onset and accelerated morbidity and mortality. The definition of CKD-MBD syndrome (which now incorporates all forms of ROD) includes any of the following: (1) abnormalities of calcium, phosphorus, parathyroid hormone (PTH), or vitamin D metabolism; (2) abnormalities in bone turnover, mineralization, volume, linear growth, or strength; and (3) vascular and extravascular calcification.[11]

Chronic Kidney Disease-Mineral Bone Disorders in the foot may begin as early as stage 2 CKD due to a small rise in serum FGF23 and sclerostin.[9,10] These serum increases may trigger a secondary hyperparathyroidism (2HPT) resulting in an elevated plasma concentration of parathyroid hormone (ie, PTH). Parathyroid hormone increases the activity and number of osteoclasts resulting in a compensatory increase in serum calcium concentration [Ca^{2+}] but with an accelerated bone loss (osteolysis) from the body's stores including the small bones of the foot.[6] Prolonged mobilization of calcium phosphate from hydroxyapatite stores in foot bones result in an accelerated osteolysis and a concomitant increase in foot vessel calcification.[12] Both of these effects increase the risk of well-known and potentially compounding effects resulting from neuropathy and vascular disease leading to foot deformities, ulceration. and ultimately LEA.

As evidence for a CKD-MBD-foot bone connection, the author has reported preliminary evidence that pedal osteolysis may start as early as stage 2 CKD when the estimated glomerular filtration rate falls to between 89-60 ml/min. Using quantitative ultrasonometry, calcaneal BMD decreases (compared to stage 1) by 12% in stage 2, by 20% in stage 3, and can average 40% loss in BMD by stage 5 or end-stage renal disease were found.[13] Compared to stage 1 CKD, there is an increasing prevalence of pedal vessel calcification beginning as early as stage 2 CKD and progressing in prevalence to 68% in stages 3, 4, and 5 CKD. The presence of pedal vessel calcification on foot radiographs of diabetic neuropathic individuals has a diagnostic odds ratio =7.2x for having CKD-MBD in the foot compared to individuals with diabetic stage 1 CKD.[13] The author believes that progressive CKD-MBD results in an increasing prevalence of pedal impairments including mid foot deformities, Charcot neuroarthropathy, and pedal vessel calcifications that ultimately result in LEA.[14,15] Physical therapist-foot and ankle specialists should continue to seek the most effective interventions to attenuate the impact of pedal CKD-MBD and to prevent non-traumatic LEA in their patients with diabetes and peripheral neuropathy.

What can physical therapists do for the foot bone-kidney connection?

With an understanding that the diabetic foot is an early target for CKD-MBD, the physical therapist-foot and ankle specialist has an evolving and important role in recognizing pedal CKD-MBD and preventing non-traumatic LEA in their patients. Routine assessment of the neural, vascular, and musculoskeletal health of your patients' feet is the key to early recognition and prevention. Any combination of diabetes, neuropathy, vascular disease, and progressive CKD should alert the patient of a need for further follow-up. A referral to the patients' primary care physician or other health care specialist including endocrinologist, podiatrist, orthopedic surgeon specialist, or vascular surgeon for more thorough evaluations including diagnostic imaging of the feet using radiography, DXA, CT, or quantitative ultrasonometry may be necessary. Alerting your patients and their health care team of any evidence of CKD-MBD-related foot impairments may initiate early interventions that can prevent many of the sequelae which lead to primary LEA.

As with most musculoskeletal impairments, recognition and early interventions are key to preventing subsequent complications. Screening for diabetic peripheral neuropathy (**Figure 1**), foot deformities, inflammation, callus and high stress (pressure) patterns on the foot, fit, and type of footwear, ulcerations in the skin and ankle-brachial indices (**Figure 2**) in each foot of every patient seen with diabetes may alert the physical therapist of developing complications in the foot.

Your patients' musculoskeletal health is a physical therapist's primary concern. Recognizing the diabetic foot-kidney connection early will potentially save your patients' feet. As the chorus of the song suggests, "Dem bones, dem bones gonna walk around, Now hear the word of the Lord." With your help, your patients are "gonna walk around" for many for years to come.

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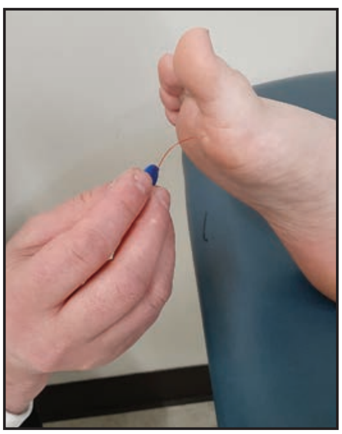
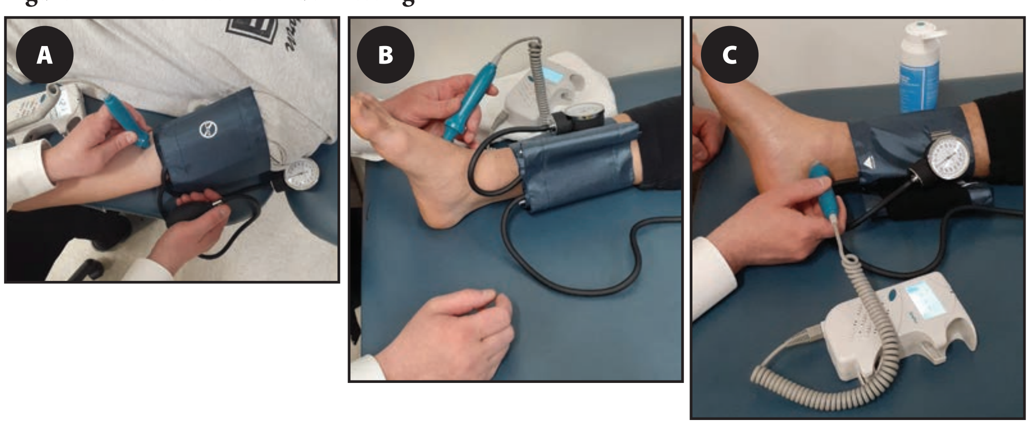
(Continued on page 184)

Figure 1. Protective Sensation Testing



Place the 10-g monofilament perpendicular to the plantar surface until you achieve the primary C shape: asking the patient to report if they feel the monofilament. Test multiple locations, lending less credence to testing over callouses. 1+ insensate locations warrants consultation on foot care and footwear. For more information check out #11 in this link: https://diabetesjournals.org/care/issue/44/Supplement_1

Figure 2. Ankle-Brachial Index Testing



Use a handheld Doppler to auscultate brachial (A) and dorsalis pedis (B) and/or posterior tibial (C) artery systolic blood pressure. For each leg separately, divide the highest ankle pressure (dorsalis pedis or posterior tibial) by the highest brachial pressure (across both arms). Values greater than 1.4 or below 0.8 warrant medical referral. For more specifics check out this link: http://stanfordmedicine25.stanford.edu/the25/ankle-brachial-index.html.
A special thank you to Donna Frownfelter PT, DPT, MA, RRT, FCCP, FAPTA for her assistance in creating this figure.

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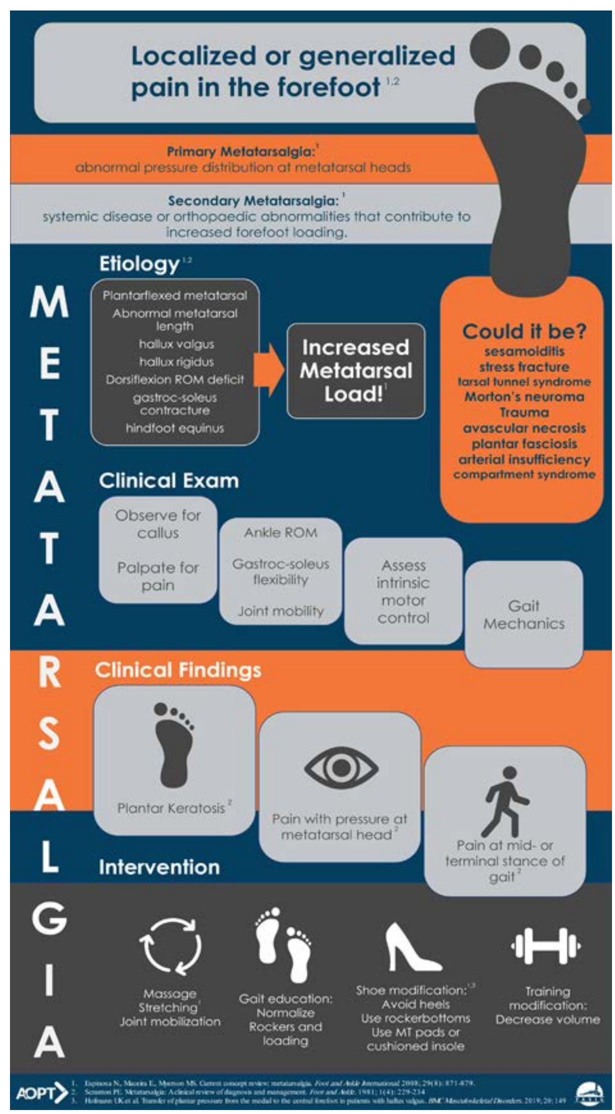
Highlights

- The diabetic neuropathic foot is at highest risk for non-traumatic lower extremity amputation.
- Chronic kidney disease-mineral bone disorder contributes to the highest risk for LEA in the diabetic neuropathic foot.
- Physical therapists should screen ALL their patients with diabetes for impairments including neuropathy, deformities, inflammation, callus (pressure) patterns, fit and type of footwear, ulcerations in the skin and ankle-brachial indices in each foot.
- If the physical therapist finds any combination of foot impairments, they should alert the patient to seek follow-up by their primary care physician and health care team.

What is an Infographic?

An infographic is a visual image such as a chart of diagram used to represent information or data. The infographics are tailored for the audience - "clinician focused" and "patient focused" version can be used to help inform care for each group.

Contact Megan Peach if you have an idea or want to help generate an Infographic (megan@excelptmt.com).



PRESIDENT'S MESSAGE

Nancy Robnett Durban, PT, MS, DPT

THE FUTURE OF THE PAIN SIG

Hello all…I hope this report finds you well, safe, and enjoying the summer. The Pain SIG has been remarkably busy the past 6 months. Here are the projects we have completed and are working on.

PAINCAST

We hope you had the opportunity to join us for our second PainCast that aired on Wednesday, June 8th. Our guests, Dr. Jake Magel and Dr. Antoinette Spector discussed the Opioid Epidemic and Physical Therapy. The PainCast recording is posted on our AOPT Pain SIG website and Facebook page. PainCast initiatives are organized and developed by Eric Kruger, PT, DPT, PhD. Please contact Eric if you have future topic suggestions.

RESEARCH REVIEW

Our last Research Review published March 30, 2022, was titled, Physical Therapist Low Back Pain Related Attitudes and Beliefs. It is published on our SIG website at Research: Abstracts, Articles, and Reviews - Academy of Orthopaedic Physical Therapy (AOPT) (orthopt.org).

GUIDE TO PHYSICAL THERAPIST PRACTICE REVISION SUGGESTIONS

A SIG workforce under Dr. Kruger's leadership, reviewed the *Guide to Physical Therapy Practice* and submitted revision suggestions that included current pain language.

STRATEGIC PLAN 2022

The SIG has been working hard to revise the strategic plan. At time of print, it should be up on our website for your review.

OFFICER REPORTS

Vice President: Eric Kruger, PT, DPT, PhD

Dr. Kruger has been busy leading many of the above-mentioned initiatives. He is currently working with AOPT Director, Derrick Sueki PT, PhD, DPT, GCPT, on exciting education opportunities for the future. Stay tuned!

Nominating Committee: Max Jordon, PT, DPT, PhD

Dr. Jordan and the Nominating Committee continue to develop an internal working timeline document for slating of candidates and position statements for chairs that align with the Strategic Plan.

Research Committee Chair: Adam Rufa PT, DPT, PhD

Dr. Rufa has contributed to the PainCast initiatives and is collaborating efforts with Dr. Kruger for research educational opportunities. Dr. Rufa and his committee are developing more Clinical Pearls that will be made available soon.

Public Relations Committee: Katie McBee, DPT, OCS

Dr. McBee has our Pain SIG Facebook page up and running. Search AOPT Pain SIG and ask to join. This is a closed site for our members.

Pain Education Manual: The Pain Education Manual is published and available. Thank you to Mark Shepherd, PT, DPT, OCS, FAAOMPT, and his workgroup for all their hard work.

Pain Specialization: Progress is slow but being made.

President's message closing…The Pain SIG would like to thank all of the AOPT office personnel, President, Bob Rowe, PT, DPT, DMT, MHS, and Director/SIG advisor Beth Collier, PT, DPT, OCS, for their continued support and guidance.

We presently have multiple opportunities for SIG involvement on the membership, public relations, and research committees. Please contact me or any other Pain SIG leader to volunteer to help our initiatives and our future.

Enjoy your summer. I hope you have time to relax and take some deep breaths.

2022 AOPT
Special Interest Group
Elections - Call for Candidates

Interested in running for office in one of our SIGs?
If you are interested in running, or know someone who might be interested, please visit our website to access the SIG Potential Candidate Forms, Nomination Form, and complete details regarding the SIG positions open for election.

ADDRESS AND REFLECTIONS

Bruno Steiner, President, AOPT Imaging SIG

Dear Members of the I-SIG,

It has been a hectic few months with conversations, meetings, and most helpful input from our family of I-SIG leadership and members and our dedicated friends from APTA governmental affairs. I remain impressed with the thoughtfulness and intelligence of our members as I continue to gain insight into the issues, impediments, opportunities, and work that lie ahead. Please indulge me if you would, and allow me to share my reflections with you thus far and highlight some of my guiding core principles.

In the words of my many mentors and colleagues over the decades, nothing beats a great physical exam. And in the words of my colleague and research collaborator, radiologist Eric Chang, MD: Radiological evaluation is guided by clinical findings and requires clinical context. However, in concert with our physical assessment, radiological evaluation certainly refines our diagnostic deliberations to better guide our patient's rehabilitative trajectory. This has been my understanding from my formative bachelor's education in Physical Therapy at McGill University in the late 1980s. My experience and DPT training have only reinforced my conviction: Physical Therapy is an evaluative, diagnostic discipline in rehabilitative medicine and benefits significantly from imaging referral/ordering and physical therapist-administered MSKUS to optimize the diagnostic clarity of a given patient's orthopedic and neuromuscular condition. Diagnostic clarity optimizes rehabilitative treatment design and expedient patient care, management, and referral for the primary care physical therapist envisioned in the Vision 2020 statement.

To be clear, I, along with all members I have met thus far, am comfortable with abandoning the mischaracterization that physical therapists 'do not diagnose.' Too long have we troubled ourselves with the contradictory logic that somehow, on the one hand, we are to objectively evaluate a patient to acknowledge/identify involved tissues, structures, and dysfunctions to form a treatment plan, while on the other hand, desperately avoid rendering our informed perspective in the commonly accepted medical language of 'diagnosis.' This awkward accommodation makes communication with providers confusing and clumsy. In my experience as a long-practicing independent practice owner in constant contact with orthopedists, hem/oncologists, providers, and healthcare consumers, this is simply untenable and patently impractical in the real world. As a graduate doctoral health care discipline, is it not time to embrace and aspire to the ideals of the Vision 2020 primary care Physical Therapist?

Given that patients in all states enjoy some measure of 'direct access' to physical therapists, we should acknowledge the de facto recognition of Physical Therapists as primary care practitioners. As primary care physical therapists, we are responsible for referring patients to appropriate providers for further input or diagnostic clarity, obviating the need for imaging referral privileges.

I invite our members to continue providing us feedback and to involve us in your respective states' drive for imaging referral privilege. If you are beginning to consider or are already advanced in the development and preparation of your ground game, please feel free to reach out to the I-SIG and our advocates who have taken on the task before you. We are ready to advise and share resources and our experience to help you actualize your goals. Our shared experiences, whether they are 'wins' or setbacks, will set the stage for future successes.

Advocacy takes on varying forms, follows many avenues and converges to common purpose. Advocacy requires engaging and educating stakeholders; however, change does not require a chronic permission-seeking mindset. We must seek legal channels and interpretations, which may already be in place, favoring our position as image-referring practitioners. This is not to say our relationships need to be adversarial. We can leverage our energy, instructive and empathetic strengths to inform, update, and modernize the misunderstandings pervasive among stakeholders. As I have been made aware, there are still legislators and stakeholders who are shocked (shocked!) that we have direct access and re-litigate uninformed fears. We are duty-bound to acknowledge their concerns but also to immediately update their regrettably antiquated notions. We are driving toward better and expedited patient care, improved public health policy, and improved multidisciplinary communication using a common diagnostic language.

As I mentioned previously, imaging referral advocacy involves several scenarios that may not be self-evident and require some nuance to avoid certain pitfalls or undesirable consequences. Not all changes require a legislative process and supplicating approval from stakeholders who have long categorically opposed the goals of our profession. Some of the most effective approaches may simply need a legal interpretation of existing language. Many practice acts may simply not explicitly contain prohibitive language to diagnostic labelling, MSKUS use, or ordering of imaging studies. As Physical Therapists, we must awaken to the reality that we can engage in legal pragmatism. Other influential lobbies have done so as well.

These approaches have been quite practical to achieve our aims: whether it involves asking calibrated questions to respective State Boards to rule or update a ruling to better reflect current modern realities and needs of the primary care physical therapist; whether it involves expanding our influence with unexpected influential stakeholders, such as radiologists and techs, to carefully time our approach to low-risk/high-reward stakeholders, while resisting conflict with stakeholders who have traditionally been at odds with our goals; and exploring the legal interpretation of our statutes, which would favor our cause.

Thanks for indulging me, and remember, please continue to 'proudly, empathically, emphatically inform and engage' our fellow stakeholders as we forge ahead for good, sound health policy and for the benefit of the patient as the aspiring primary care Physical Therapists you are.

And now, let's get a bit more granular with some updates from our leadership, researchers, and governmental affairs for all things imaging and, near and dear to my heart, physical therapist-administered MSKUS.

Developments in Physical Therapist-administered MSKUS

Inteleos reports that 17 Physical Therapists have taken the APCA (Alliance for Physician Certification and Accreditation) RMSK exam in the latest cycle. To remind everyone, physical therapists are eligible for the Physician's board certification of the

APCA conferred RMSK distinction, which has resulted in the board accreditation of numerous physical therapists. And we have shown over and over again that we can pass it. Remember, Physical Therapists are recognized providers of Musculoskeletal Ultrasonography by the American Institute of Ultrasound in Medicine (AIUM) and the Inteleos Foundation family of certification alliances. The credentialing academies include the Alliance for Physician Certification and Accreditation (APCA), The American Registry of Diagnostic Medical Sonographers (ARDMS), and The Point-of-Care Ultrasound Certification Academy (POCUS). Moreover, the AIUM recognizes physical therapists as 'licensed medical providers' of MSK ultrasound.

I have repeatedly stated that if you wish to unequivocally demonstrate our MSKUS competency, learn MSKUS, apply it, prepare, and sit for the exam. It is an unambiguous and undisputable statement of competency. We wish our next class of 17 physical therapists good fortune and hope that more will experience the professionally transformative use of MSKUS to extend our Physical Exam and join the ranks of the RMSK PT.

Diagnostic Ultrasound Sales to Physical Therapists

Some of our fellow physical therapists encountered occasional difficulty purchasing diagnostic ultrasound devices from vendors and manufacturers due to a misinterpretation of FDA labeling. Our former president, yet very active I-SIG member Chuck Hazle, identified an opportunity to engage this stakeholder with an informative APTA-approved position paper. I have written and submitted a statement, incorporating the insights and input from him and Doug White, reviewed by Physical Therapists Cindy Bailey, Jim Dauber, and Mark Krimmel (all of whom use MSKUS). It is in the final stages of approval from APTA governmental affairs and will be a tool for physical therapists to use to allow us to purchase diagnostic ultrasound devices.

MSKUS Infographic

Thanks to Beshoy Ghaly, DPT, RMSK, who has diligently worked on the AOPT I-SIG infographic of PT-administered MSKUS. It is a great additional resource posted on our I-SIG web page and I encourage everyone to review and download it.

Noteworthy Publications

MSKUS adoption and learning strategies

The Imaging SIG Research Committee recently published a paper titled, Elements of Learning and Integration of Diagnostic Musculoskeletal Ultrasound Imaging Into Practice: Physical Therapists' Educational Journeys. The paper's authors are Lorna Hayward, Alycia Markowski, Maureen Watkins, Murray Maitland, Rob Manske, and George Beneck.[1] The study set out to understand the learning process and practice of musculoskeletal ultrasound (US) by physical therapists registered in musculoskeletal sonography. Using a qualitative approach, 16 US credentialed physical therapists were interviewed. Five themes regarding learning and clinical use of ultrasound imaging were identified. Numerous quotes by the participants were included to support the reported themes.

Emerging case reports of physical therapists ordering imaging studies

If you wondered what imaging referral looks like in practice and wanted to glimpse a successfully implemented workflow, *Physiotherapy Theory and Practice* just published Private physical therapy practice implementation of direct referral for radiograph imaging: an administrative case report.[2] Nelson et al describe the successful implementation of direct referral for radiography studies in a physical therapist-owned, private physical therapy practice. Evan Nelson and colleagues have agreed to talk with our membership to dive into their encouraging experience in a world where physical therapists directly refer for imaging.

Imaging advocacy: *Physical Therapy Journal* article

Additionally, I would strongly encourage everyone to read the most recent *Physical Therapy Journal* article, Putting Imaging into Focus (https://www.apta.org/apta-magazine/2022/03/01/putting-imaging-into-focus).[3] Author Chris Hayhurst interviews physical therapists who are passionately involved in imaging referral for our profession and explores the role of imaging in physical therapy. This excellent article serves as an essential primer, introduction, and overview of the issues and possibilities facing physical therapist imaging referral. Interviewees include devoted advocates Aaron Keil, Lance Maubry, Charles Hazle, Daniel Markels, Michelle Collie, Drew Contreras, and Katie O'Bright.

A word from our I-SIG VP, Education Chair: Brian Young

The Imaging SIG has been busy expanding the use of imaging within physical therapist practice. Much imaging education has focused on entry-level skills with the first Imaging Education Manual. The 2022 CSM presentation, Demonstrating Competencies in Referral for Imaging, by Dr's Michael Ross, Michael Crowell, Aaron Keil, Michelle Collie, Bill Boissonnault, and Brian Young, expanded the conversation beyond entry-level DPT education to now include residency, fellowship, and health systems. Why is this important? Because more states are working for practice act rule changes to allow physical therapist referral for imaging. This does not affect just entry-level DPT students but those who have been in practice.

Ensuring Consistency with Current Evidence in Imaging-CPGs

Dr. Jim Dauber (Marshall University) is leading a task force facilitating the introduction of evidence-based musculoskeletal clinical decision-making into emerging and revised clinical practice guidelines, emphasizing incorporating the American College of Radiology Appropriateness criteria as part of physical therapist best practice. The taskforce functions in a liaison capacity between the Imaging Special Interest Group and the Orthopaedic Academy's CPG Managing Editor, Namrita Sidhu. The Imaging SIG is also initiating microlearning sessions for imaging referral and are available free of charge to physical therapists on the AOPT's website.

American Institute of Ultrasound in Medicine

Finally, we are continuing our educational efforts in collaboration with the American Institute of Ultrasound Medicine to provide free-of-charge webinars on the utilization of MSKUS by physical therapists for patient management. The Imaging SIG is invested in spreading the word about physical therapists' effective, safe, and responsible use of imaging. Stay tuned and be sure to join us in our future educational efforts!

State Legislative Round-Up: Justin Elliott, Vice-President, APTA Governmental affairs

Last year, we saw North Dakota and Rhode Island enact legislation amending their state licensure law (ie, practice act) to permit physical therapists to order x-rays. Also, in December 2021, the West Virginia Board of Physical Therapy issued an advisory opinion that imaging referral is within the practice of "physical therapy" as defined by West Virginia law. The West Virginia Board of Physical Therapy advisory opinion issued in December 2021 determined that imaging referral is within the practice of "physical therapy" as defined by West Virginia law. The opinion was issued in response to an inquiry by the West Virginia APTA chapter. The opinion states that it "is advisory in nature and does not constitute an administrative rule or regulation and is intended to solely serve as a guideline for persons licensed by the West Virginia Board of Physical Therapy."

In 2022 two states, Georgia and Arizona, introduced legislation that would expressly allow physical therapists to order diagnostic imaging. Georgia HB 1514, as drafted, would have allowed physical therapists to order diagnostic imaging and use ultrasound. HB 1514 defines diagnostic imaging as magnetic resonance imaging, computed tomography (CT) scanning, positron emission tomography (PET) scanning, positron emission tomography/computed tomography, and other advanced imaging services but not X-rays, fluoroscopy, or ultrasound services. Unfortunately, Georgia HB 1514 did not receive a hearing, and the Georgia Legislature has adjourned for the year. Arizona SB 1312 would allow physical therapists to order musculoskeletal imaging consisting of plain film radiographs. The legislation passed the Senate unanimously but has yet to be voted on in the Arizona House as the legislature looks to adjourn for the year soon.

The APTA Imaging SIG and the APTA State Affairs Department continue to educate APTA chapters on the role of physical therapists and imaging and anticipate more states to seek legislation, regulations, and board policies and opinions in the coming months that expressly allow physical therapists to refer patients for imaging studies. APTA and the Imaging SIG continue to work with the Federation of State Boards of Physical Therapy (FSBPT) to educate state boards on this issue. Last year FSBPT hosted an educational webinar for state licensure board members titled, Imaging Referral by Physical Therapists: Progression of PT Education, Advocacy, Practice, and Regulation, featuring Chuck Hazel, Daniel Markels (APTA State Affairs manager), and Jeanne DeKrey of the North Dakota Board of Physical Therapy. APTA and the Imaging SIG are also currently working with FSBPT on the inclusion of model legislative language related to PT referral for imaging for the next edition of the Model Practice Act for Physical Therapy (MPA); the MPA is the model legislative language used by state chapters and boards when revising a state PT practice Act. FSBPT has also posted imaging information on their website that links to the resources on the APTA Imaging SIG website.

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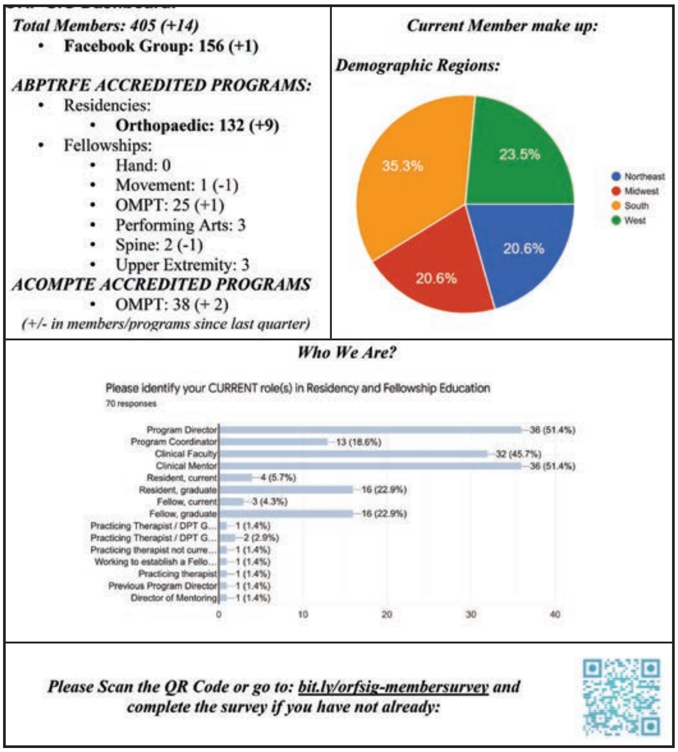
ORF-SIG Dashboard:



PRESIDENT'S MESSAGE

ORF-SIG Members,

"We delight in the beauty of the butterfly, but rarely admit the changes it has gone through to achieve that beauty."
– Maya Angelou

Spring is a time of awakening and hope. We have all undergone immense challenges the past few years in a variety of ways. Our clinical landscapes are different; most of us are trying to regain some sense of normalcy and many feel challenged as things are still not back to the way they were before. We have been working as a leadership team to focus our energies for the year ahead. We want to be sure that we are working on aspects that will benefit and ease some of the burden felt by our residency and fellowship community. Some of the areas that we are focusing on include recruitment of applicants, spotlighting existing programs, efficiency with teaching and mentoring, and assisting new programs in the development phases. I have highlighted in greater depth some of these programs below. As we know, many hands make for light work so get involved with the ORF-SIG to continue to move these initiatives forward. I can honestly say this group of directors, residents, and fellows inspire me daily. If you would like to get more involved within the SIG, make sure to reach out to malloyma@arcadia.edu. My hope for all of you as that we look back at the end of this year to many butterflies which have undergone changes but are still amazing and advancing our profession daily.

Thank you for all of the work you are each doing every day!

Molly Malloy
President, ORF-SIG

ADDITIONAL RESOURCES

Applicant Registry: Steve Kareha, Molly Malloy, Kirk Bentzen, Carrie Schwoerer

One big problem facing programs over the years is the ability to sustain consistent applicant bases despite using or not using RF-PTCAS. Our team had been working hard to collect interested applicants to attempt to steer them to open positions. We are brainstorming to revise this system to tackle the problem from the front end focusing on the following:

1. Raise awareness for our programs,
2. Steer qualified applicants to our programs, and
3. Address the problems of open positions throughout the country.

Please let me know if you are interested in joining this discussion; we will be meeting in June 2022.

In the meantime, you can continue to use this link for an excess of applicants who you are open to sharing of their information. Specifically for those qualified applicants who are excellent candidates and have already been vetted but applied to a program that does not have any available spots. The program denying admission may then provide the applicant with a flyer explaining the database and providing them the option to participate. Member programs may access these qualified, vetted applicants as needed by contacting Steve Kareha (stephen.kareha@sluhn.org). Updates on the numbers of candidates in this list will be provided quarterly to the membership.

a. Currently, everyone who was on this list has been admitted into a program.

Residency & Fellowship
Qualified Applicants

http://bit.ly/3u0JR0s

PROGRAM RESIDENT/FELLOW/FACULTY SPOTLIGHT: CAITLYN LANG, KRISTINE NEELON, BOB SCHROEDTER

What is the program spotlight?

It is an ORF-SIG, member-only feature that allows one or more orthopaedic residency/fellowship programs to be spotlighted within a given month to market themselves to prospective candidates and those seeking more information on post professional education in orthopaedics. Additionally, programs will also be spotlighting individual faculty and/or residents/fellows-in-training as good-will ambassadors of their respective programs.

What are the benefits to being spotlighted?

Programs that are spotlighted advance the exposure and interest in post professional orthopaedic physical therapy programs across the country, thus bolstering their program's sustainability. Furthermore, by providing important, decision-making details about their program a prospective candidate can make a better-informed decision about which program may be a good fit for them.

Who is eligible to apply?

Program coordinators or program directors may apply for their program as long as they meet the following pre-application criteria:

- The program must be ABPTRFE or ACOMPTE accredited or in Candidate status.
- The Program Director or Coordinator must be a member of the AOPT and ORF-SIG.
- The Program Director or Coordinator must have a specialization in Orthopaedics.

Please visit: https://www.orthopt.org/content/special-interest-groups/residency-fellowship/orf-sig-program-spotlight/spotlight-program-faqs

ABPTRFE FREQUENTLY ASKED QUESTIONS DOCUMENTS

Recently, the American Board of Physical Therapy Residency and Fellowship Education (ABTPRFE) released updates to their Policies and Procedures including some changes to the Primary Health conditions and CoVid-19 accreditation recommendations. The ORF-SIG was able to work with the Chair of ABPTRFE, Mark Weber, and the Lead Accreditation Specialist, Linda Csiza. Together, they provided some further elaboration on several Frequently Asked Questions. Check out these documents here:

- Policy 13.5 Addition of Practice Sites FAQ
- Primary Health Conditions / Medical Conditions List FAQ
- CoVid-19 Temporary Guidance FAQ
- Program Sustainability: Applicant Sharing and Recruitment FAQ

RF-PTCAS: KIRK BENTZEN, STEVE KAREHA, MEGAN FRAZEE, CARRIE SCHWOERER, CHRISTINA GOMEZ

If you are a new program or need a refresher on some of the nuances of the processes and timelines, please review the following podcast: Navigating RFPTCAS, which can be found at: https://musc.hosted.panopto.com/Panopto/Pages/Embed.aspx?id=0841c14e-a3f7-4196-b654-acd90169c9e2. Presenters of this podcast included Ryan Bannister, Director-Centralized Application Services and Student Recruitment and Orthopaedic Residency and Fellowship SIG leadership, including Kirk Bentzen, Christina Gomez, and Steve Kareha.

Please contact Carrie Schwoerer (cschwoerer@uwhealth.org) with questions.

OTHER KEY RESOURCES:

ABPTRFE Updates: Community HUB

Don't miss out on the latest ABPTRFE Updates from Kendra Harrington:

- Updates to ABPTRFE Processes and Procedures
- What Sites Should, and Should Not, Be Included on the Participant Practice Sites?
- ABPTRFE Recent Actions
- July 1 Policy Reminder

ACOMPTE Website and Resources:

Orthopaedic Manual Physical Therapy Fellowship programs find ACOMPTE Information here:

APTE RF-SIG Resources: Christina Gomez

aptaeducation.org/special-interest-group/RFESIG/

You can also find more great information from the Academy of Education's Residency and Fellowship SIG (RFESIG). Here you will find a variety of Podcasts they have completed for Residency and Program Directors. Please make sure to check these out as well as the Think Tank resources.

- Virtual Site Visit
- RF-PTCAS Reminders

Take advantage of our member-only communication forums to share and develop ideas.

ORF-SIG Facebook group

bit.ly/orfsig-fbgroup

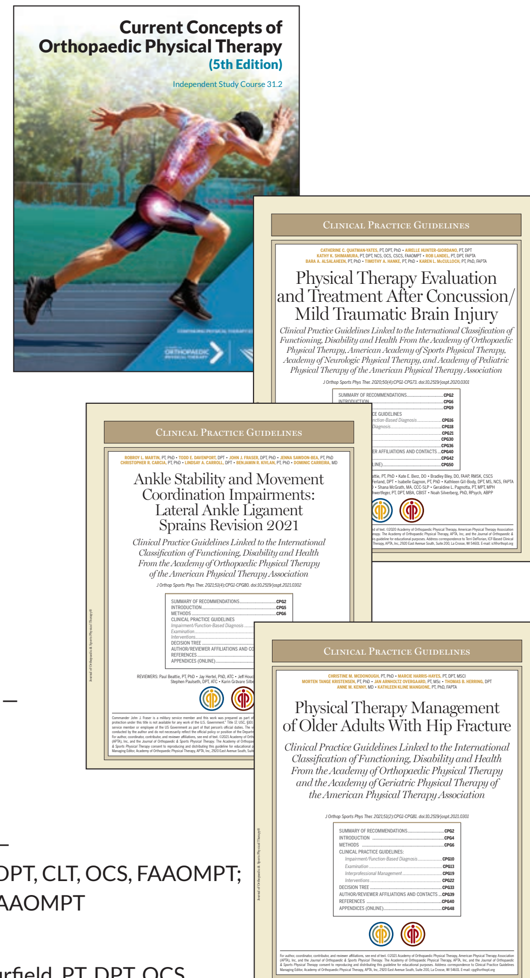
AOPT ORF-SIG Communities HUB

bit.ly/orsig-communityhub

NEED HELP TO PREPARE FOR THE OCS?

Check out AOPT's Current Concepts and Clinical Practice Guidelines (CPGs)

Current Concepts of Orthopaedic Physical Therapy, 5th ed.



Topics and Authors

- **Integration and Application of the Scientific Method, Evidence-based Practice, and Clinical Reasoning**—Sean P. Riley, PT, DPT, ScD
- **The Cervical Spine: Evidence-Informed Physical Therapy Patient Management**—Eric K. Robertson, PT, DPT, OCS, FAAOMPT; Mary K Derrick, PT, DPT, OCS, FAAOMPT
- **The Temporomandibular Joint: Evidence-Informed Physical Therapy Patient Management**—Sally Ho, PT, DPT, MS, OCS; Kai-Yu Ho, PT, MSPT, PhD
- **The Thoracic Spine & Rib Cage: Evidence-Informed Physical Therapy Patient Management**—Scott Burns, PT, DPT, OCS, FAAOMPT; Michael O'Hara, PT, DPT, OCS; William Egan, PT, DPT, OCS, FAAOMPT
- **The Shoulder: Evidence-Informed Physical Therapy Patient Management**—Amee L. Seitz, PT, PhD, DPT, OCS; Heather Christain, PT, DPT, OCS, SCS; Adam Lutz, PT, DPT, PhD; Ellen Shanley, PT, PhD, OCS
- **The Elbow: Evidence-Informed Physical Therapy Patient Management** —Mark Dutton, PT
- **The Wrist & Hand: Evidence-Informed Physical Therapy Patient Management** — Mia Erickson, PT, EdD, CHT, ATC; Carol Waggy, PT, PhD, CHT
- **The Lumbar Spine: Evidence-Informed Physical Therapy Patient Management**—Max Jordan, PT, DPT, PhD
- **The Pelvic Girdle: Evidence-Informed Physical Therapy Patient Management** — Kathleen Chizewski Caulfield, PT, DPT, OCS, FAAOMPT; Leanna Blanchard, PT, DPT, CLT, OCS, FAAOMPT; Michael O'Hearn, PT, MHS, OCS, FAAOMPT; Carol A. Courtney, PT, PhD, ATC, FAAOMPT
- **The Hip: Evidence-Informed Physical Therapy Patient Management**—Keelan Enseki, PT, MS, OCS, SCS; Dave Kohlrieser, PT, DPT, OCS, SCS; Allison Burfield, PT, DPT, OCS
- **The Knee: Evidence-Informed Physical Therapy Patient Management**—Wm Gregory Seymour, PT, DPT, OCS, FAAOMPT; Scott Fenstermacher, PT, DPT, GCS, OCS; Jerry Smith, PT, DPT, OCS; Scott Dickenson, PT, DPT, SCS; Patrick Carter, PT, DPT; Tara Jo Manal, PT, DPT, OCS, SCS
- **The Foot and Ankle: Evidence-Informed Physical Therapy Patient Management** — Lindsay A. Carroll, PT, DPT, OMPT; Stephen Paulseth, PT, MS, DPT, ATC; John J. Fraser, PT, DPT, PhD; RobRoy L. Martin, PT, PhD, CSCS

Additional Questions, Call 800/444-3982

Current Concepts of Orthopaedic Physical Therapy:
https://www.orthopt.org/course/31-2-current-concepts-of-physical-therapy-5th-edition

Clinical Practice Guidelines:
https://www.orthopt.org/content/practice/clinical-practice-guidelines

ACADEMY OF ORTHOPAEDIC PHYSICAL THERAPY

APTA American Physical Therapy Association

Index to Advertisers

Congratulations to our 2022 Honors and Awards Program Recipients

The following members from the Academy of Orthopaedic Physical Therapy have been selected to receive the following APTA awards:

Dorothy Baethke-Eleanor Carlin Award for Excellence in Academic Teaching	Marsha E. Rutland, PT, BSPT, MEd, ScD Board-Certified Clinical Specialist in Orthopaedic Physical Therapy
Lucy Blair Service Award	Patricia Wolfe, PT, MS
F A Davis Award for Outstanding Physical Therapist Assistant Educator	Christina D. Howard, PT, MPT, EdD
Catherine Worthingham Fellow	Deydre S. Teyhen, PT, DPT, PhD, FAPTA
Catherine Worthingham Fellow	Joseph J. Godges, PT, DPT, MA, FAPTA Board-Certified Clinical Specialist in Orthopaedic Physical Therapy
Catherine Worthingham Fellow	Laurence N. Benz, PT, DPT, MBA, FAPTA Board-Certified Clinical Specialist in Orthopaedic Physical Therapy
Catherine Worthingham Fellow	Philip Paul Tygiel, PT, FAPTA
Federal Government Affairs Leadership Award	Theresa Marko, PT, DPT, MS Board-Certified Clinical Specialist in Orthopaedic Physical Therapy
McMillan Scholarship Award - Physical Therapist	Bana Odeh, PT, DPT
McMillan Scholarship Award - Physical Therapist	Sydney Reynolds Neumann, SPT
McMillan Scholarship Award - Physical Therapist	Sydney Lazzell, SPT
Eugene Michels New Investigator Award	Joshua J. Stefanik, PT, MSPT, PhD
Eugene Michels New Investigator Award	Stephanie Di Stasi, PT, PhD
Minority Scholarship Award	Michelle Dennis, PT, DPT
Minority Scholarship Award	Olutayo Akinboboye, PT, DPT
Margaret L Moore Award for Outstanding New Academic Faculty Member	Ryan David Zarzycki, PT, DPT, PhD
Recognition of Legislative Commitment	Thomas J. Bohanon, Jr., PT, DPT Board-Certified Clinical Specialist in Orthopaedic Physical Therapy
Marian Williams Award for Research in Physical Therapy	Julius (Jules) P.A. Dewald, PT, PhD
Marian Williams Award for Research in Physical Therapy	Steven Z. George, PT, PhD, FAPTA

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