# Orthopedic Elective Course PHYT 785: Fall 2013

**Performance-Related Musculoskeletal Disorders of String Musicians**

**Introduction**Musicians are a unique subset of patients requiring physical therapy. The lifestyle of a musician is physically and emotionally demanding. Achieving a position in an elite musical ensemble requires intense competition and exceptional musical ability. In addition to the stress of performing for professional success, musicians may face occupational hazards including anxiety, second-hand smoke, noise, altered sleep cycles, postural stress, and musculoskeletal injury.1,2,3

Musculoskeletal injury in musicians, referred to as performance-related musculoskeletal disorders (PRMDs), encompasses pain, weakness, numbness, tingling, and other symptoms that interfere with a musician’s ability to play a primary instrument effectively.1 PRMDs are a common part of the life of a professional musician, but these injuries undermine the musician’s ability to perform and may lead to career termination with detrimental effects on health and livelihood.1,2,4

Musculoskeletal injuries affect all ages and all classes of professional, amateur, and student musicians with a high occurrence.2 Brandfonbrener2 summarized a 1988 survey finding that 76% of 2212 professional orchestral musicians in the United States reported having a performance-affecting PRMD at some point in their careers. A 2012 survey of 377 professional orchestral musicians in Australia determined that 84% previously experienced PRMD and 28% missed a day of work in the past 18 months because of PRMD.1 Fifty percent of these professional musicians had pain and injury at the time of the survey with half reporting pain lasting more than 12 weeks.1The risk of PRMDs is reportedly highest in string players and keyboardists.4 Despite the frequency of injury in individual musicians, limited research exists with high levels of evidence analyzing methods to prevent and treat musculoskeletal injuries in musicians. The present review of musculoskeletal injuries in musicians resulted in an analysis of 13 articles. Of these, the majority were commentaries and expert opinion written by surgeons and physicians. Some explanation for the shortage of research could be that only in the last 10-20 years have physicians recognized the extent of problems caused by musculoskeletal injury in musicians.2 Another factor may be the variety of types of instruments, playing techniques, and resulting injuries that occur, which limit the ability to make solid comparative studies. Additionally, Foxman & Burgel3 comment on the low incomes and low rates of health insurance among musicians. Limited financial means and access to healthcare could influence the funding of research for musculoskeletal injuries in musicians. This trend may change, as the US Bureau of Labor Statistics5 reports that the 2010 median hourly pay for musicians and singers is $22.39, more than a 20% increase than the hourly pay when Foxman & Burgel3 published their review in 2004.

Despite several potential reasons for limited high levels of evidence, efforts are increasing to produce evidence and promote education to prevent PRMDs.1 Medical Problems of Performing Artists is an international movement with a peer-reviewed journal that supports conferences, clinics, and research centers with a goal of increasing knowledge and reducing injuries in performing artists.1 This paper attempts to work toward this goal by describing common types of injuries in string musicians, evaluating risk factors for injury, explaining recommendations for evaluation of musicians, summarizing techniques for injury prevention, and discussing treatment options.

**Common Performance-Related Musculoskeletal Disorders**

Performance induced medical problems in musicians are categorized into musculoskeletal disorders, nerve entrapments, and focal dystonias.2,3,6,7 Entrapment neuropathies cause pain, weakness, and sensory abnormalities along affected nerves. Electrodiagnostic testing is typically required for effective diagnosis with potential for conservative or surgical treatments.7 Focal dystonia is painless loss of motor control with unknown etiology.2,3,7,8 Spasms, uncontrolled contractions of small muscle groups, and unintentional movements worsen over time. Deep brain stimulation and use of botulinum toxin show some potential as treatment, but focal dystonia typically leads career termination for musicians.7 Although entrapment neuropathies and focal dystonias are more severe for musicians, musculoskeletal injuries are far more common. Types of musculoskeletal injuries in musicians vary based on intrinsic factors of the musician and extrinsic factors of the instrument and environment. As a result, published literature regarding PRMDs is often general rather than focused on specific locations. In the literature, the type of PRMD most commonly discussed is repetitive stress injury or overuse syndrome.4,6,7,8,9 Hansen & Reed4 described overuse syndrome as a term used when a more specific diagnosis could not be determined, making it the ultimate diagnosis of the majority of PRMDs. Brandfonbrener2 preferred the term “musculoskeletal pain syndrome” because of a similar concern that overuse syndrome was an inaccurate catch-all diagnosis. The variability of repetitive stress injury for musicians makes its pathology difficult to define, but the assumption is that tissues are stressed beyond their physiological limits.4 Physiologic examples of overuse injuries include muscle damage that accumulates through microhemorrhages, tears occurring at tendon-bone insertion sites, tendinosis and sprains of proximal tendons, tendon creep, and muscle ischemia.8

**Risk Factors & Mechanisms of Injury for Performance-Related Musculoskeletal Disorders**

Throughout the articles reviewed, common themes were repeatedly discussed regarding mechanism of injury for musculoskeletal injury in musicians. Poor posture is frequently implicated as an etiology for musculoskeletal injury in musicians.4 The playing posture for certain instruments can be awkward, particularly when the instrument is not properly fitted to the musician. Violinists and violists may inappropriately clench their instrument between their shoulder and chin.2 This improper posture requires upward and anterior rotation of the scapula with forceful left cervical rotation. Tension from this prolonged position can lead to injuries of the jaw, cervical spine, shoulder, and left upper extremity.2 Improper sitting and standing posture also contributes to performance related musculoskeletal disorders. Cellists and bassists have common complaints of back pain caused by sitting in improperly fitted chairs and stools or from leaning over their instruments.2,4

When musicians forego physical exercise, the result is underdevelopment of postural musculature strength and endurance with greater stress placed upon muscles that have increased tone from musical practice.1,2 A lack of physical fitness and a stressful lifestyle further exacerbate the risk of poor posture as a factor in musculoskeletal injury in musicians.2

Poor posture causes not only neck and back pain, but also injuries to the hand, wrist, forearm, and shoulder.2,10 A questionnaire and physical exam survey of 72 professional and university student cellists by Rickert et al10 linked poor posture, sedentary lifestyle, long hours of playing, and weak proximal musculature to high rates of right shoulder dysfunction. Physical examination of cellists in the study by Rickert et al10 established a significant decrease in right shoulder range of motion of professional cellists compared to university cellists. Professional cellists also experienced approximately twice the prevalence of right shoulder injuries. For comparisons within groups of right to left shoulders, significant differences were found regarding scapulohumeral dysrhythmia, shoulder height, scapular winging, and pain with testing. Rickert et al10 concluded from these results that decreased scapular support, poor posture, and muscle imbalance led to injuries such as right shoulder impingement, pain, and loss of motion negatively affecting cellists.

Muscle imbalance from smaller muscle groups similarly contributes to injury.2,4 Upper extremity flexion dominates resting positions of the violin, viola, cello, and double bass.2 Left hand finger flexion supplies force into the fingerboard, and right hand finger flexion grips the bow. Some shortening of the forearm flexors can occur as a result of the chronically flexed and forceful positions.2 The shortening of the flexors along with the excess strengthening of the flexors compared to the extensors can stress the extensors, leading to pain and tendinosis characterized as epicondylitis.2

Joint laxity as a risk factor for PRMDs is unclear. The prevalence of joint hypermobility in musicians is estimated to be between 5 and 25%, higher than in the general population.7 Theoretically, a musician with increased laxity will utilize greater muscle force to stabilize inherently unstable joints. This force, through the forearm flexors, requires increased stress from the opposing extensors.2,7 Brandfonbrener2 reported anecdotal accounts of patients with hyperlaxity as a primary risk factor for PRMD. However, Larsson et al11 analyzed effects of joint hypermobility among 660 musicians in a quasi-experimental study with no control or randomization. They determined that musicians with hypermobility of the wrists and elbows had a decreased incidence of musculoskeletal pain and symptoms in these areas.11 Larsson et al11 attributed the decreased rate of injury to decreased stress felt in lax tissues with the repetitive motion of musical practice. With published results offering different opinions of joint laxity and risk for PRMD, the relationship should be considered individually for each musician.

Ergonomics influence development of musculoskeletal disorders in musicians.4 Musicians of different instruments report pain in different anatomical regions, suggesting that physical demands of each instrument differently influence risk for injury.1 Individual body size and mechanics also affect ergonomics. A smaller person inherently experiences greater requirements of stretch and force from her upper body than a larger person when playing a large instrument such as a full size cello or double bass.2 Females may experience more performance-related musculoskeletal disorders than men because of smaller body size.2 Playing an instrument that is too large is a risk factor for injury in children.12

Practice is a necessary factor for success in a performance musician.4 Excessive practice can lead to overuse injuries. In a cross-sectional survey by Ackermann et al,1 75% of 377 professional orchestral musicians reported that training and playing load contributed to personal performance-related musculoskeletal disorders. Excessive or long practices sessions were associated with increased muscle tension, muscle fatigue, and insufficient rest as risk factors for PRMDs. Ackermann et al1 found that musicians whose practice sessions lasted longer than 80 minutes had the greatest number of injuries, whereas subjects whose practice sessions were 55 minutes or shorter had fewer injuries. Foxman & Burgel3 reported that music students who practiced more than 20 hours in a week had a greater risk for PRMDs.

Sudden changes are often associated with performance-related musculoskeletal disorders. Such changes could be increased playing time related to an upcoming performance or audition, a new teacher, a new instrument, or a new piece of music.2

**Assessment and Evaluation of Musicians**

The musician comes to a health care professional for problems that affect her health, livelihood, and art.13 As with all patient-provider interactions, the formation of trust and professionalism must be built early in the evaluation. With copious risk factors to analyze, the duration of the initial evaluation of musicians may be longer than for other patients, and more time should be set aside for the appointment.13

Musicians have a self-awareness of their upper extremities that is uncommon among the general population, and the musician-patient has likely already tried self-examinations and self-treatments prior to consultation with a health care professional.13 With the knowledge and specialization that the musician brings to the interaction, it is important that the provider is also familiar with the technical details of musical performance.3,13 A provider’s knowledge of instrumental playing builds trust in the patient-provider relationship and enables imperative insight into minor details which may affect the musician’s injury, treatment, and healing.13 A multidisciplinary approach to evaluation has been recommended by several authors.2,4,13 The multidisciplinary team could include a musical expert for additional information regarding technique, a psychologist for stress and anxiety-related influences on career-impacting pain, and a primary care provider for medical management of pain or underlying illness while physical therapy focuses on addressing the mechanism of injury, rehabilitating injured tissue, and improving holistic fitness.

Subjective information and history gathering by the provider should be open ended to provide a complete picture of the musician from her start as an artist to her present condition.13,14 In addition to typical physical therapy examination questions such as localization of pain, timing, pain characteristics, influences, and associations,14 a musical evaluation must also include associations of symptoms with the patient’s musical education, practice habits, performance of secondary instruments, current and former repertoire, current and former teachers, current and former playing techniques, current and former jobs and performances, pending performances, and non-musical recreational and exercise activities.13 All aspects of the musician’s previous and current career, recreation, and health must be considered for possible influences on injury. A complete musculoskeletal evaluation is necessary depending upon results from the subjective assessment.13 In addition to general musculoskeletal evaluation of range of motion, strength, habitus, symmetry, and special testing, neurologic examination should be performed to assess sensation and reflexes.4 The musician must be observed playing her instrument for analysis of muscular balance, posture, tension, and ergonomics.2,4,13 Hansen & Reed4 recommended that this observation occur after a practice session so that the therapist can observe the musician as she fatigues and symptoms occur. Videotaped practice sessions may also be a useful tool in identifying postural and technique changes with prolonged playing.4 Blum13 suggested observing the musician from multiple angles, including from above, to obtain a complete picture of posture and symmetry. The goal of the initial assessment is to perform a neurologic and musculoskeletal evaluation on the patient, analyze all risk factors previously listed, listen carefully to the musician’s subjective reports and history, observe her playing technique, and identify a potential mechanism of injury for the chief complaint. From there, a plan of treatment and prevention can be implemented. Referral to neurologists, rheumatologists, orthopedists, or other medical providers may occur based on differential diagnosis following initial evaluation.2,4

**Treatment Options**

Early detection and implementation of treatments based on findings from the evaluation are often effective for complete recovery from overuse injuries in musicians.8 Treatment should consist initially of educating the musician on the mechanism of injury and the need to implement changes to prevent further trauma.8 The musician should be counseled toward good nutrition and hydration with limited caffeine, smoking cessation, and implementation of aerobic and strengthening exercise.6,8 The musician must be taught gentle warm-up exercises to include at the beginning of music practice sessions and prior to performance to increase circulation and prepare tissues for movement.6,8 Incorporating physical therapy exercises for strength and endurance into music practice sessions can help the patient adhere to exercises as well as provide needed breaks during practice. Postural spine and shoulder exercises are often needed to improve stability and reduce tension in distal muscles. As an example of a postural exercise, Shafer-Crane8 recommended the pelvic clock. With this exercise, the patient lies supine, imagining a clock on their abdomen with 6 inferiorly and 12 superiorly as shown in the Pelvic Clock Figure. The patient is instructed to rock her pelvis toward individual hours on the clock using only abdominal muscles. Once this task is mastered in supine, the patient can transfer the skill to sitting in a chair, standing, or sitting on an exercise ball. A musician can try this exercise while playing scales or a simple piece of music. Shafer-Crane8 suggested that therapists instruct musicians to gently stretch posterior shoulder capsules, wrist flexors, wrist extensors, and elbow flexors during practice and rehearsal breaks.

Addressing extrinsic mechanical and ergonomic factors is also a necessary part of treatment. One example of an ergonomic treatment for pain in the right upper extremity of a string musician is to alter bowing technique. There are three schools of bow position: German position, French-Belgian position, and Russian position, each of which requires different right finger and wrist positioning resulting in subtle differences in muscles used.13 Acceptance by the musician to change bowing style may require support from her teacher and possibly other professional colleagues, but it the change in the placement of force among joints in the right hand can be a successful treatment for right arm pain and bowing failure.13

Additional ergonomic treatments include alteration of chin and shoulder rests for violins and violas. These extensions of the instruments provide increased stability and comfort for the musician but can induce awkward biomechanics if they are poorly placed or sized.13 For example, the result of a shoulder rest that is too small could be increased cervical compression leading to the development of pain and numbness in the left hand.

Other treatments that involve equipment considerations include fitting the instrument to the musician. All string instruments come in varying sizes, and playing a full size instrument is no longer the hallmark of a professional musician. Playing an instrument that fits the person reduces extreme postures and injury.12 Fitting the technique to the musician is a less tangible requirement for healing from injury. Different teachers often emphasize different techniques, but a good teacher will help each student identify the playing technique that best fits the student’s body and avoids methods that require excessive stretching or tension.2

In addition to addressing the mechanism of injury, the injured tissue requires protection during recovery. Hansen & Reed4 reported that collaboration with teachers, conductors, and managers can be helpful in composing and administering realistic practice schedules that provide adequate rest to healing tissues. Hansen & Reed reported an 80% success rate for musicians with overuse injuries who practice relative rest followed by gradual return to normal playing schedules. During the period of relative rest, the musician must utilize ergonomically recommended instruments and equipment, practice pieces that are not technically demanding, and practice for short periods of time. Warm-up prior to practice is indicated along with relaxation, hydration, proper nutrition, and exercise outside of practice. Splinting, nonsteroidal anti-inflammatory medications, and steroid injects are debatably helpful and should be carefully considered for each individual patient.2,4 Brandfonbrener2 stated that steroid injection and surgery should be avoided in musicians except in the case of trauma or spontaneous disruption of tissues. Brandfonbrener2 reported that surgical outcomes are not favorable for musicians in whom small amounts of scar tissue can be detrimental to performance.

In a quasi-experimental study with no control group, no randomization, no objective outcome measures beyond reports of pain and return to play, and no statistics, Fry9 described two treatment interventions applied to musicians with overuse injuries. The conservative treatment was similar to advice previously listed by Hansen & Reed,4 in which practice segments were limited to 15-25 minutes at a time with outside incorporation of physical activity. A radical rest treatment involved avoiding all painful use of the involved limb, including musical practice.9 Subjects were placed into either group depending on severity of injury. A total of 13 violinists, violists, cellists, and bassists were placed into the conservative rest group. After approximately 8 weeks, 9 of the 13 successfully resumed normal playing. 22 string players were placed into the radical rest group, and 12 experienced complete recovery after a varying period of time up to 5 months.9 Despite limitations in this study, Fry9 suggested indication for partial rest in musicians with overuse injury and a need for further research. Foxman & Burgel3 recommended that musicians undergoing recovery from injury participate in music composition, arranging, or research to continue work in their field despite separation from performance.

**Recommendations for Injury Prevention**

Whereas past musicians were often told, “No pain, no gain,” injury prevention is a necessary and growing concern among schools of music.2,4,6,15 Lledo et al15 recommended that education to reduce future risk of PRMDs should begin in childhood. Controlling risk factors is a primary method for injury prevention.4 Monitoring ergonomics such as lighting, positioning of music stands, chair height, and instrument size can prevent injuries caused by awkward spine, hand, and finger postures.4 Utilizing safe lifting methods or adding wheels to instrument cases can prevent injuries caused with instrument transportation and travel.12  
Maintaining a healthy lifestyle can reduce likelihood of injury in musicians. Regular physical activity can prevent muscular imbalance and poor posture that may contribute to injury.1,2,6,8 When discussing physical activity programming with musicians, it is important to consider the safety of the musician’s upper extremities. Lead musicians toward activities such as swimming, strength training, and walking as opposed to basketball or other sports that can cause upper extremity injuries.6

Lledo et al6 proposed that musicians of all ages should warm up prior to practice or performance, beginning with a global exercise such as walking. This should be followed by specific dynamic exercises with the instrument going from low to high complexity.6 Ongoing postural training and core strengthening in string musicians is necessary to enable safe compensation for asymmetric postures and loading required by their instruments.6,8

The importance and effectiveness of introducing injury prevention strategies was illustrated in a randomized controlled trial at a prestigious music conservatory in Spain in 2013.15 Ninety students participated in an experimental group that received a program of warm-up exercises and postural hygiene along with a course on the prevention of musculoskeletal injuries for one year.15 The control group received no intervention and were advised to continue their practice regimen as desired. At the beginning of the experiment, 74.5% of control participants and 85.5% of experimental participants reported PRMDs. The year-long intervention led to no change in the control group but a 77.9% decrease in PRMD reports in the experimental group.15 Ninety percent of students in the study reported an opinion that a course on injury prevention should be a required part of the curriculum. Other findings from this study included increased evidence of body awareness and physical condition in the experimental group, correct performance of warm-up exercises in the experimental group compared to the control group, and greater frequency of performance of warm-up exercises in the experimental group compared to the control group.15 These early outcomes suggest promising results from education of students regarding injury prevention.

**Implications for Physical Therapy and Future Research**

The rates of injury in professional and student musicians are astonishingly high. Brandfonbrener2 concluded that medical practitioners of performing artists must encourage greater prevention through reduction of risk factors. With such practitioners in short supply except in areas of musical prestige,16 it becomes the role of general health care providers and music teachers to promote good body mechanics, posture, and practice habits to musicians with and without performance-related musculoskeletal disorders. The current lack of published randomized controlled trials on specific treatment or injury prevention methods beckons for more research. North Carolina offers a promising laboratory with a variety of types of professional and university musicians. UNC Chapel Hill’s Department of Music is home to over 70 renowned professional musicians and scholars and over 200 students, yet there does not appear to be a course related to injury prevention. An intervention study could be designed at UNC Chapel Hill to contribute to the growing knowledge and promotion of health and wellness of musicians.

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**Pelvic Clock Exercise:8** The patient lies supine with a mental image of a clock on their abdomen. For this exercise, the patient rocks her pelvis toward each hour of the clock using only abdominal muscles.

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