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PERFORMING ARTS MEDICINE

Performing arts medicine — Instrumentalist musicians: Part III — Case histories

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Summary In parts I and II of this article series, the basic principles of examining musicians in a healthcare setting were reviewed [Dommerholt, J. Performing arts medicine — instrument alist musicians: part I: general considerations. J. Bodyw. Mov. Ther., in press-a; Dommerholt, J. Performing arts medicine — instrumentalist musicians: part II: the examination. J. Bodyw. Mov. Ther., in press-b]. Part III describes three case reports of musicians with hand pain, interfering with their ability to play their instruments. The musicians consulted with a performing arts physiotherapist. Neither musician had a correct medical diagnosis if at all, when they first contacted the physiotherapist. Each musician required an individualized approach not only to establish the correct diagnosis, but also to develop a specific treatment program. The treatment programs included ergonomic interventions, manual therapy, trigger point therapy, and patient education. All musicians returned to playing their instruments without any residual pain or dysfunction.

Introduction

Parts I of this article series outlined the basic principles of the history and examination of musicians within the context of healthcare (Dommerholt, in press-a, in press-b). While many aspects of the examination and treatment outlined in this article are applicable to other professions as well, the focus of this article is on the physiotherapy assessment and management. Readers are encouraged to place the case reports within their own discipline. Because musculoskeletal injuries are the most common disorder among musicians, it follows that physiotherapists would play an important role in the management and prevention of injuries (Dommerholt and Norris, 1997; Brandfonbrener, 2000). Yet, in a study commissioned by the International Conference of Symphony and Opera Musicians only 13% of 2212 musicians associated with 48 major symphony orchestras in the United States had consulted with physiotherapists (Fishbein et al., 1988). In 1994, the American Physical Therapy Association established the Performing Arts Special Interest Group [PASIG], which aims to be ''a leading authority in performing arts physical therapy [...] through professional development and dissemination of current information/trends, current practice, research initiatives and outreach programs with performing

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artists and performing arts groups'' [https://www.orthopt.org/sig_pa.php, accessed February 11, 2009]. In 2004, the PASIG published a practice analysis survey to initiate the development of clinical guidelines, which showed that after dancers, musicians are the second most common population treated by performing arts physiotherapists (Gamboa et al., 2004). The PASIG includes dancers, instrumentalists and vocal musicians, ice skaters, and gymnasts in its definition of performing arts physiotherapy. In spite of the efforts of the PASIG and other performing arts medical associations, relatively few articles have appeared in the physiotherapy literature about the specific physiotherapy management of musicians (Gamboa et al., 2004).

Performance-related injuries are almost always preventable (Wynn Parry, 2003; Fjellman-Wiklund and Chesky, 2006). Physiotherapists can educate musicians, music students, teachers, and managers of performing arts organizations, which has been shown to be very effective (Dommerholt and Norris, 1997; Hildebrandt and Nubling, 2004). Most music teachers have not received any education on care of the physical body of musicians (Redmond and Tiermman, 2001). Musicians need to learn and accept that their physical body is part of the instrument and deserves and requires the same level of attention and care (Dommerholt et al., 2000). Teachers familiar with injury mechanisms and prevention strategies are essential in instructing students accordingly (Hildebrandt and Nubling, 2004).

Physiotherapists and other healthcare providers can initiate prevention programs in music schools or orchestras. Preventative exercise program or movement re-education classes have proven track records in reducing playing-related musculoskeletal problems (Spaulding, 1988; Chong et al., 1989; Wakely, 1998; Ackermann et al., 2002; de Greef et al., 2003). For example, a fifteen-week self-awareness program to reduce injuries and improve musicians' perceived physical competence demonstrated a significantly reduced injury rate compared to a control group. Forty-five percent of the decrease in injuries was a direct result of an increase in physical competence (de Greef et al., 2003). An injury prevention program at a Norwegian conservatory was very effective (Spaulding, 1988). A Dutch symphony orchestra contracted with a physiotherapist to conduct a weekly consultation clinic available to all members of the orchestra. The program has been well received, and has been shown to reduce the rate of musculoskeletal disorders (Wakely, 1998). Strength and especially endurance programs directed at music students reduced their perceived exertion of playing (Ackermann et al., 2002). Musicians do not necessarily make regular exercise part of their daily routine, which increases their risk of injury. Poor proximal strength, endurance, and stability result in poor posture, increased stress on distal muscles, and overuse injuries. The combination of poor and constrained postures, flawed practice habits, repetitive movements, poor physical conditioning, stressful work conditions, faulty ergonomics, and poor awareness are direct causes of injury (Lowe, 1992; Quarrier, 1993; Dommerholt and Norris, 1997; Dommerholt, 2000; Brandfonbrener, 2006). Shafer-Crane emphasized trunk stabilization, shoulder stabilization, upper quadrant strengthening, stretching, and overall conditioning as the main components of a prevention program for musicians (Shafer-Crane, 2006).

Case histories

This article documents the physiotherapy management of three musicians with hand pain. Each case illustrates different aspects of the physiotherapy evaluation process and physiotherapy management. Although the article is written from the perspective of a performing arts physiotherapist, the principles are applicable to other healthcare providers as well.

The bassoonist

The patient was a 19-year-old male college student who experienced disabling pain in the left index finger, but only when he played the bassoon. He was on a full music scholarship and played in the university's symphony orchestra and in other school ensembles. During his high school years, he had switched from saxophone to bassoon at the recommendation of his music teacher, who had advised him that colleges have much difficulty in finding high-level bassoon players and the likelihood of getting music scholarships would be considerably greater for bassoon players than for saxophonists. The patient had played the bassoon for only three years. In preparation of his college auditions, he had increased his practice time considerably and often would play 6—8 h daily. Since he had been accepted to the school on a full scholarship, he practiced approximately 5 h daily in addition to orchestra rehearsals, private lessons, and other ensemble engagements. When asked about his practice habits, he admitted playing nearly continuously without regular breaks. He did not use any practice methods without playing the instrument, such as shadow-playing or mental practice.

During the period that he prepared for the auditions, he had experienced similar pain in his left index finger, but the pain was not constant and did not interfere with his ability to play. Upon entering college, he started studying with a new teacher, but with few significant changes in his playing technique. After approximately six weeks in the music school, he started experiencing frequent pain in his left index finger. Two months later he consulted with a performing arts physiotherapist. The onset of pain started after approximately 5—10 min of playing the bassoon. The pain would increase unless he stopped playing. Rest periods did not seem to make much difference. When he would start playing again, the pain would start again after 5—10 min. At its worst, he rated his pain as a ''8'' on a visual analog scale ranging from 0 to 10, with ''0'' being equal to ''no pain'' and ''10'' the ''worse level of pain he could imagine.'' When he stopped playing, the pain would subside within minutes. The musical repertoire did not have any impact on the onset of pain. Other activities of daily living did not evoke the patient's pain complaint. He did not experience any pain in his finger unless he played the bassoon. There were no other pertinent findings from the history (for a review of pertinent questions, see part I of this series).

The patient was examined with and without the bassoon. The examination without the bassoon revealed normal muscle strength of the finger flexors, extensors, and interossei using manual testing. Range of motion was significant for the finding of hypermobility of the metacarpophalangeal joints of all his fingers. Passive extension was measured at 80 degrees and was not painful. Palpation of the extensor digitorum muscle and the finger flexors did not trigger the patient's familiar pain. Local palpation of the intrinsic hand muscles and the wrist and finger extensors did not reveal any discomfort either. He did not have systemic whole-body hypermobility. Hypermobility was limited to the upper extremity.

Examination of the patient while playing the bassoon showed a mismatch between the patient's hand size and the size of the instrument. In order to wrap his fingers around the bassoon, he kept his hand and fingers tightly against the instrument, which caused excessive passive hyperextension of the metacarpophalangeal joints (see Figure 1). At the same time, he held his left arm closely against his trunk in an adducted position of the shoulder. The patient did not present with any other obvious impairments, which would explain the onset of disabling pain.

Discussion

From a music medicine perspective, the patient's status was rated as a grade 1 on the Functional Grading of Severity of Injury scale (Fry, 1986). As mentioned in part I of this article series, the Functional Grading of Severity of Injury scale is commonly used to determine the impact of pain on playing musical instruments. In this case, the pain was limited to one site and the onset of pain was brought on by playing the instrument. The pain did not persist away from the instrument and did not persist on rest.

From a US physiotherapy perspective, it is recommended to use the Guide to Physical Therapy Practice to classify and diagnose patients' problems (American Physical Therapy Association, 2001). The Guide is developed by the American Physical Therapy Association and is based on Nagi's disablement model (Nagi, 1965, 1969, 1991; American Physical Therapy Association, 2001). In this model, four interrelated concepts are identified, including pathology/pathophysiology, impairments, functional limitations, and disability (American Physical Therapy Association, 2001). Pathology refers to a disease, disorder, or condition and usually corresponds to the medical diagnosis. Impairments are the consequence of disease, pathological processes, or lesions, and are defined as ''abnormalities of structure or function.'' When impairments result in the inability to perform a physical activity, task, or activity in an efficient, typically expected, or competent manner, physiotherapists formulate functional limitations. Disability according to the model is defined as ''the inability or restricted ability to perform actions, tasks, and activities related to self care, home management, work (job/school/play), community, and leisure roles in the individual's sociocultural context and physical environments'' (American Physical Therapy Association, 2001).

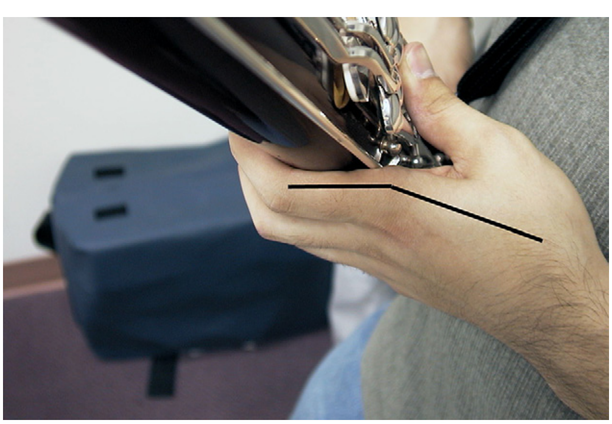

Figure 1 Hyperextension of the metacarpophalangeal joint due to a mismatch between hand anthropometry and size of the instrument (© 2008 — Jan Dommerholt).

The patient did not present with a clear pathological or pathophysiological condition. He had not seen a physician for this problem and did not have a medical diagnosis. The patient's hypermobility of the metacarpophalangeal joint appeared to be causative of the pain he experienced during playing the bassoon and as such, hypermobility was diagnosed as an impairment. Hypermobility was particularly problematic, because of a mismatch between the patient's hand anthropometry and the size of the bassoon. As a result of the impairment, the patient was functionally limited as he was no longer able to play the bassoon without pain. Because he could not overcome his functional limitation and was not able to play his instrument and meet the expectations of his work as an orchestra musician in the college symphony orchestra, he was considered disabled.

Following the examination, physiotherapists categorize each patient into specific practice patterns, which direct the management plan. The Guide identifies four categories of conditions: musculoskeletal, neuromuscular, cardiovascular/pulmonary, and integumentary. Each category consists of several sub categories (American Physical Therapy Association, 2001). The patient was categorized into musculoskeletal practice patterns B (Impaired Posture) and D (Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated with Connective Tissue Dysfunction). As hypermobility was thought to be the primary impairment, pattern D was the primary musculoskeletal pattern. The Impaired Posture during playing the instrument was considered a secondary pattern.

The therapeutic management of this patient posed several interesting challenges. The Guide distinguishes three intervention strategies: coordination, communication, and documentation (American Physical Therapy Association, 2001). The patient had not consulted with other healthcare providers, which limited the coordination and communication to the physiotherapist and the patient. Patients who are being seen by other practitioners require a more comprehensive level of coordination and communication. Because the patient did not present with distinct pathological findings, his treatment plan was mostly functionally oriented. Initially, the patient was instructed to position his left upper arm into scaption, which positioned his hand in a more relaxed position at the instrument. Unfortunately, with his arm in scaption, he was not able to maintain good contact with the instrument and he was not able to play at all.

As the patient was full-grown and bassoons do not vary much in size, there were limited options of modifying the fit between the patient's hand and the instrument. We considered modifying the keys and extend the keys toward the player's hand. As an alternative, we considered using a so-called plateau key, which is a covered key with a pad for the third finger of the left hand. A plateau key replaces the traditional ring key and allows small hands to more comfortably close a finger hole. The patient was however, quite concerned about making modifications to his instrument, and he preferred other less permanent modifications, which is a common response of musicians faced with modifying their instruments (Ostwald, 1992).

Placement of a few layers of gauze in between the left hand and the instrument did correct his hand and shoulder positions reasonably well, but was not a permanent position (see Figure 2).

After two months of searching for a suitable solution, the problem was finally corrected using Silopad pressure sensitive dots. The dots feature an adhesive, which made it possible to attach the dots directly to the instrument, without damaging the veneer of the bassoon. Silopad pressure sensitive gel dots were originally designed for the treatment of pressure or friction induced lesions, such as blisters or calluses, but they proved ideal to correct the patient's hypermobility and to eliminate the direct pressure of the hand on the instrument (see Figure 3).

Prior to discharge from physiotherapy, the patient was educated regarding proper practice habits. With the Silopad, he was able to return to playing the bassoon full-time without any pain or other restrictions. He received a small supply of dots for future use. Three years after discharge, the patient contacted the physiotherapist. He reported that his pain had not returned. However, he had run out of pressure sensitive dots and ordered an additional set.

In summary, the patient returned to playing the bassoon on a full-time basis without any restrictions or residual pain. Although his music career was seriously threatened, the problem was corrected after only one physiotherapy examination and treatment.

The guitarist

The patient was a 30-year-old male amateur classical guitarist, who had not been able to play the guitar due to severe pain and limited range of motion of the left thumb. During a hiking trip two-and-a-half years earlier, a backpack fell on his outstretched left thumb, causing immediate pain. He reported that the thumb and the thenar prominence were swollen for several days following the accident. He did not seek medical attention for several weeks, but he did consult eventually with a physician who diagnosed him with having a muscle strain and prescribed non-steroidal anti-inflammatories. After two months, he continued to have severe pain with movement and limited range of motion of the left thumb, at which point he consulted with a hand surgeon. The hand surgeon made a diagnosis of ''scar tissue'' and referred him to a hand therapist. The patient reported that he did not see any obvious signs of scar tissue, but the hand therapist confirmed the diagnosis of scar tissue. He had several weeks of occupational therapy/hand therapy, but he did not gain much progress. He was informed that due to the scar tissue, he would not be able to play the guitar anymore. He was not able to position his left thumb behind the neck of the guitar and play the instrument. He discontinued hand therapy and stopped playing guitar. Occasionally, he tried to play the instrument, but his limited thumb range of motion prevented him from playing comfortably. The pain in the thumb eventually subsided somewhat, but was always present especially with any use of his thumb.

After reading a newspaper article about music medicine, the patient consulted with a performing arts physiotherapist. He reported that he had been playing guitar since high school. He started taking private classical guitar lessons approximately 8 years before the accident. He had always studied with the same teacher. As he was unable to play guitar at all, questions about his repertoire, playing, and practice habits were only relevant to gain a better understanding of his pre-injury status and his potential return-to-play objectives. At the time of the initial evaluation, he rated his pain as a ''5'' on a visual analog scale ranging from 0 to 10, with ''0'' being equal to ''no pain'' and ''10'' the ''worse level of pain he could imagine.'' Any activity involving the thumb, including playing the guitar, increased his pain levels immediately. He suffered from persistent movement-activated pain in the thumb region. The pain was located in the thenar prominence and in the thumb. He

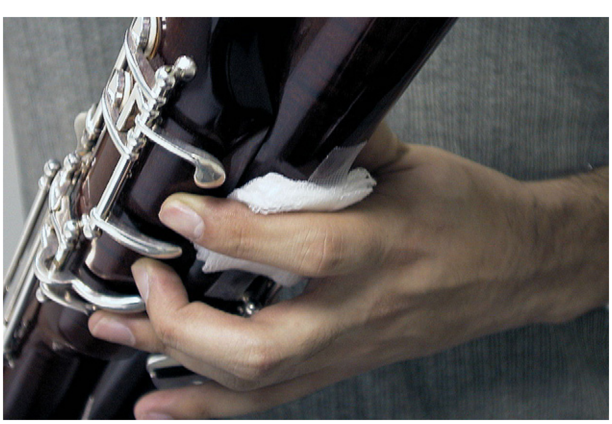

Figure 2 Correction of hyperextension at the metacarpophalangeal joints using several layers of gauze (© 2008 — Jan Dommerholt).

Figure 3 Correction of hyperextension and direct pressure using Silopad pressure sensitive dots (© 2008 — Jan Dommerholt).

characterized the pain as a deep, aching pain, but he was unable to identify the location of the pain exactly.

Visual inspection of the left hand did not reveal any abnormalities. The examination of his left hand revealed significantly decreased active abduction and extension of the first carpometacarpal joint of no more than 15 degrees. Passive range of motion was 25 degrees for abduction and extension and painful in the patient's end range. Pain was located over the thenar eminence. The right thumb had full range of motion in all planes. Wrist range of motion was within normal limits. Resisted abduction, circumduction, adduction, flexion, and extension of the thumb were painful. Palpation of the thumb musculature revealed taut bands with myofascial trigger points in the abductor pollicis brevis, the opponens pollicis, the adductor pollicis, and the first dorsal interosseus muscles. Palpation of the trigger points elicited a familiar pain to the patient. The patient did not bring his guitar to the initial physiotherapy appointment.

Discussion

The patient's status was rated as a grade 4 on the Functional Grading of Severity of Injury scale (Fry, 1986). He had persistent pain irrespective of playing the musical instrument. The pain increased with any use of the thumb, including activities of daily living. A grade 5 was considered, because he was no longer able to play the instrument. However, because he did still had functional use of his hand, a grade 5 seemed inappropriate.

Following the Guide to Physical Therapy guidelines, the patient's active myofascial trigger points were considered his pathology. His impairment was restricted range of motion. His functional limitation was not able to play guitar without pain, leading to disability. The patient was categorized into musculoskeletal practice patterns C (Impaired Muscle Performance) and D (Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated with Connective Tissue Dysfunction) (American Physical Therapy Association, 2001).

Although myofascial pain has been reported as the most common diagnosis responsible for chronic pain and disability in other populations, few reports on musicians' specific soft tissue dysfunctions have considered myofascial pain in the differential diagnosis (Rosomoff et al., 1989a,b; Skootsky et al., 1989; Fricton, 1990; Hendler and Kozikowski, 1993; Rosen, 1993; Dommerholt and Norris, 1997; Davies, 2002; Dommerholt et al., 2006a,b; Gerwin and Dommerholt, 2006). A survey of physician members of the American Pain Society showed general agreement that myofascial pain and trigger points exist as distinct clinical entities (Hendler and Kozikowski, 1993; Harden et al., 2000). Yet, generally speaking, physiotherapists do not pay much attention to myofascial pain. Very few articles about muscle dysfunction and trigger points have been published in the physiotherapy literature, and few physiotherapists have received training and education in pain management strategies (Dommerholt, 2005; Dommerholt et al., 2006a,b). The term ''myofascial pain'' is sometimes used without referring to trigger points and their characteristic features, which can be confusing (Wee and Brandfonbrener, 2005).

Myofascial trigger points are the hallmark characteristic of myofascial pain and have been described as ''hyperirritable spots in skeletal muscle that are associated with hypersensitive palpable nodules in taut bands (Simons et al., 1999). An active trigger point is a symptom-producing point, which can trigger local and referred pain or other paresthesia. Active trigger points cause muscle weakness and decreased range of motion. A latent trigger point does not trigger pain without being stimulated, but may alter muscle activation patterns and limit range of motion (Lucas et al., 2004; Lucas, 2008). Gentle palpation of a trigger point can trigger a patient's familiar pain, which indicates that trigger points contribute to peripheral and central sensitization (Fernández-de-las-Peñas et al., 2007). Normally, skeletal muscle nociceptors require high intensities of stimulation and they do not respond to moderate local pressure, contractions, or muscle stretches (Mense, 2003). Trigger points cause persistent noxious stimulation, which results in an increase of the number and size of the receptive fields to which a single dorsal horn nociceptive neuron responds, and the experience of spontaneous pain and referred pain (Mense, 1994). Myofascial trigger points are identified through either a pincer palpation technique, in which a muscle is palpated between the clinician's fingers, or a flat palpation technique, in which a clinician applies finger or thumb pressure to muscle against underlying bony tissue (Simons et al., 1999; Dommerholt et al., 2006a,b). Several recent studies have determined excellent intrarater and interrater reliability for identifying myofascial trigger points (Gerwin et al., 1997; Sciotti et al., 2001; Al-Shenqiti and Oldham, 2005; Bron et al., 2007).

Many studies have confirmed that myofascial trigger points are common not only in persons attending pain management clinics, but also in internal medicine and dentistry (Graff-Radford, 1984; Fricton et al., 1985; Rosomoff et al., 1989a,b; Skootsky et al., 1989; Gerwin, 1995; Chaiamnuay et al., 1998). In fact, myofascial trigger points have been identified with nearly every musculoskeletal and other pain diagnoses (Dommerholt et al., 2006a). For example, a study of adults with frequent migraine headaches diagnosed according to the International Headache Society criteria showed that 94% of the patients reported migraineous pain with manual stimulation of cervical and temporal trigger points, compared with only 29% of controls (Headache Classification Subcommittee of the International Headache Society, 2004; Calandre et al., 2006). In 30% of the migraine group, palpation of trigger points elicited a ''full-blown migraine attack which required abortive treatment.'' The researchers found a positive relationship between the number of trigger points and the frequency of migraine attacks and duration of the illness (Calandre et al., 2006). In a study of 110 adults with low back pain, myofascial pain was the most common finding affecting 95.5% of patients (Weiner et al., 2006).

There are no controlled studies of the incidence or prevalence of myofascial pain among musicians. One retroactive study reported that 73% of musicians diagnosed with overuse syndrome had in fact myofascial pain, however, this study did not include a control group (Moran, 1992). Facial myofascial pain was most prevalent among violists, violinists and brass players (Bryant, 1989; Taddey, 1992). Meador reported the treatment of a viola player with myofascial pain with trigger points in the latissimus dorsi and teres major muscles (Meador, 1989).

Back to the guitarist, the initial focus of the physiotherapy intervention was on inactivating myofascial trigger points in the abductor pollicis brevis, the opponens pollicis, the adductor pollicis, and the first dorsal interosseus muscles. Trigger points can be inactivated manually with muscle energy techniques, trigger point compression or transverse frictions, with ultrasound or laser, or invasively using trigger point dry needling or injections (Majlesi and Unalan, 2004; Fernández-de-las-Peñas et al., 2005, 2006; Dommerholt et al., 2006a,b; Rickards, 2006; Srbely and Dickey, 2007; Blikstad and Gemmell, 2008; Dearing and Hamilton, 2008; Gemmell et al., 2008; Srbely et al., 2008). Several recent studies, including a Cochrane review, have confirmed that trigger point needling is an effective intervention (Hong, 1994; Furlan et al., 2005; Dommerholt et al., 2006a,b; Ga et al., 2007a,b; Giamberardino et al., 2007; Hsieh et al., 2007).[1] As part of the physiotherapy program, musicians can learn self-treatment strategies for myofascial trigger points (Davies, 2002). The reader is referred to two recent review articles on myofascial pain and dry needling (Dommerholt et al., 2006a,b).

The patient consented to being treated with trigger point dry needling. Myofascial trigger points were inactivated with solid filament needles with a diameter of 0.16 mm and a length of 20 mm (see Figure 4).

Multiple local twitch responses were elicited per trigger point. A local twitch response is an involuntary spinal cord reflex of the muscle fibers in a taut band following snapping palpation or needling procedures (Hong and Torigoe, 1994; Hong et al., 1995). Eliciting local twitch responses are essential when trigger points are inactivated with either dry needling or injections (Hong, 1994; Dommerholt et al., 2006a,b). They are unique to trigger points. The dry needling procedures were followed with manual trigger point therapy (Dommerholt and Issa, 2003; Dommerholt et al., 2006a,b). After three treatments, the patient had full, but still painful range of motion of the thumb in all directions. After five sessions, he was pain-free with all movements of his left thumb. He was seen for five more sessions spread out over several weeks, during which only manual techniques were used in combination with patient education. The patient had to learn that he could start playing guitar again, after having been convinced that playing would never be possible again. During that period, he was asked to bring in his instrument for an instrument-specific evaluation.

Figure 4 Trigger point dry needling of the adductor pollicis muscle (© 2008 — Jan Dommerholt).

The most striking finding of the instrument-specific evaluation was that the neck of his guitar was much too narrow for the size of his hands (see Figure 5).

To position his hand around the neck, he had to use a forced pincer grip, requiring prolonged isometric muscle contractions. This was interpreted as a significant risk factor for future overuse injuries. The patient was advised to replace his instrument if at all possible, or to at least limit playing and practice time to very brief episodes. The patient decided to replace his instrument and he commissioned a guitar builder to construct a new instrument. Physiotherapy was discontinued at that time. Once the instrument maker was ready to complete the neck of the instrument, the patient returned to physiotherapy to determine the ideal thickness of the neck for his hand anthropometry in close coordination with the instrument

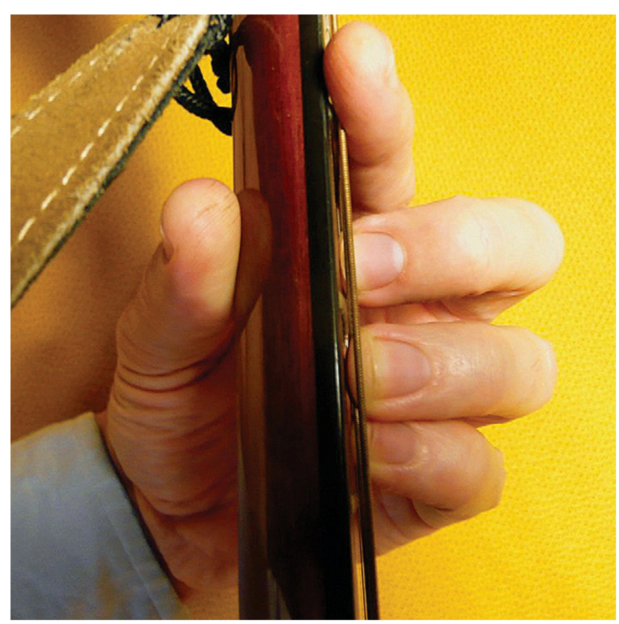

Figure 5 Narrow neck of the guitar compared to the size of the player's hand (© 2008 — Jan Dommerholt).

[1] Trigger point dry needling is within the scope of physical therapy in many countries, including Australia, Canada, Ireland, the Netherlands, New Zealand, Norway, South Africa, Spain, and the United Kingdom, among others. Currently, physical therapy boards of eleven US states have ruled that dry needling is within the scope of physical therapy practice, including Alabama, Colorado, Georgia, Kentucky, Maryland, New Hampshire, New Mexico, Ohio, South Carolina, Virginia, and Texas. A few state boards ruled that dry needling would not fall within the scope of physical therapy practice, including Hawaii, Nevada, New York, North Carolina, and Tennessee. In most other states, it has not been determined at this point in time (Dommerholt et al 2006).

Figure 6 Ergonomically improved interface with a broader neck of the guitar matching the size of the player's hand (© 2008 — Jan Dommerholt).

maker. After the instrument was completed, he returned for three additional physiotherapy sessions, during which he was educated about gradually returning to playing the guitar. The new guitar fit his relatively large hand size (see Figures 6 and 7). He was discharged from physiotherapy after a total of thirteen sessions. Five years later, he was still pain-free and continued playing guitar without any restrictions. He even recorded a demo CD of his music.

In summary, this patient had been erroneously diagnosed with ''scar tissue''. In spite of not having played at all for a period of two-and-a-half years, he was able to resume playing the guitar once he was treated for myofascial trigger points in combination with correcting the ergonomic aspects of the player—instrument interface.

The organist

The patient was a 26-year-old female professional organ player, who complained of severe pain in the radial aspect

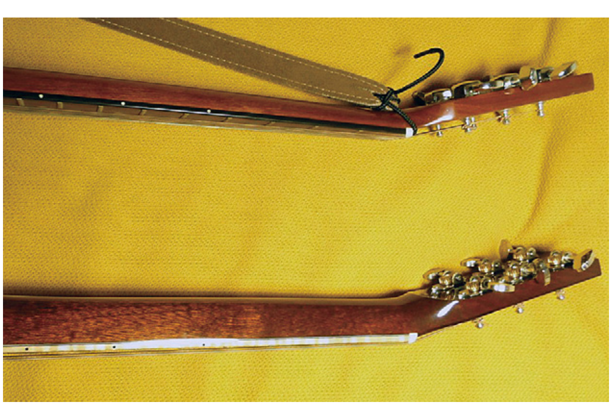

Figure 7 Comparison of the old and new guitar (© 2008 — Jan Dommerholt).

of the right wrist and thumb. The pain started approximately three months before her visit to a performing arts physiotherapist. She was still able to play the organ and piano, but had to stop playing the organ after less than 10 min and the piano after approximately 20 min, due to the onset of severe pain. The pain decreased away from the instruments, but never resolved. The pain significantly impacted her ability to use her right hand with other activities of daily living. She was no longer able to meet the demands of her job as church organist, choir director, and music teacher. The pain had started insidiously and she could not identify any precipitating event. Within two months following the onset of pain, she was no longer able to play. As her career was seriously threatened, she consulted with three orthopedic surgeons, who were unanimous in their diagnosis of de Quervain's syndrome. Two of the three surgeons recommended immediate surgical repair and informed her that delaying the surgery would jeopardize her ability to ever play the organ again. The third orthopedic surgeon recommended a course of physiotherapy combined with pharmacological management, but did not rule out surgical intervention if physiotherapy would not resolve her pain. The patient was reluctant to submit to surgery and consulted a performing arts physiotherapist for another non-surgical opinion.

She reported that she started playing piano at the age of six. She switched to organ when she was fourteen. She had a variety of music teachers until she went to college, where she got a bachelor's degree in organ. She planned to pursue graduate studies in organ, but the current pain levels had shattered that dream. More urgently, she was very concerned about not meeting the demands of her job as church organist. In that function, she was expected to not only play during church services, but she was also responsible for playing during any other church function, including funerals, weddings, and other special occasions. She was also the director of several church choruses and responsible for selecting the music repertoire for the church services and the choruses. Her job demanded her playing several hours daily. In addition, she was an organ and piano teacher with 15 weekly students. She played several organ recitals throughout the year. The patient received free housing from the church and she was afraid that she would be forced to move if she would not be able to perform the duties of her job. The patient reported that the repertoire made no difference in her pain. She did admit practicing several hours without regular breaks, but did not feel that her practice habits contributed to the onset of pain.

The patient could easily identify the area of pain over the radial aspect of the right wrist and thumb. She rated her pain as an ''8'' on a visual analog scale ranging from 0 to 10, with ''0'' being equal to ''no pain'' and ''10'' the ''worse level of pain he could imagine.'' Visual inspection of the hand, thumb, wrist, arm, shoulders, and neck did not reveal any obvious deficiencies. There were no signs of swelling in the wrist and thumb, including the anatomical snuff box region. She did have relatively small hands considering that she was an organist. In spite of her smaller hand size, she had been able to meet the demands of the instrument. She did present with forward head posture, protracted shoulders, internal rotation of the upper extremities, and overall poor core stability (slouched posture), but her posture did not seem to contribute to the sudden onset of pain. The patient presented with hyperabduction and hyperextension of both thumbs. Measurements of strength of the thumb muscles in adduction, extension, flexion, abduction, and circumflexion were within normal limits and did not cause any additional pain.

The patient tested positive for the Finkelstein test and she confirmed that the orthopedic surgeons had performed the same test. Surprisingly, when the Finkelstein test was performed with the elbow in extension, the test was negative with the patient reporting having no pain in the wrist and thumb. She did complain of the familiar pain with pronation of the forearm combined with ulnar deviation of the wrist. This suggested that the pain she experienced was not due to stenosis of the first dorsal compartment or inflammation or irritation of the extensor pollicis brevis or abductor pollicis longus. The position of the elbow and forearm has no mechanical effect on the first dorsal compartment.

The patient was also examined for other possible causes of pain in the thumb, including referred pain from myofascial trigger points. She presented with latent myofascial trigger points in the right infraspinatus, supraspinatus, medial scalene, brachioradialis, supinator, and extensor carpi radialis longus muscles. It was not clear however, whether these trigger points contributed to the pain complaint as she did not recognize the pain patterns associated with trigger point palpation, which is why these trigger points would be classified as latent trigger points (Dommerholt et al., 2006a).

Discussion

The patient's status was rated as a grade 5 on the Functional Grading of Severity of Injury scale (Fry, 1986). She had persistent pain irrespective of playing the organ or piano. The pain increased with any use of the thumb and hand, including activities of daily living, and seriously threatened the patient's musical career at the time of the initial physiotherapy evaluation. The physiotherapy diagnosis was more challenging, as it appeared that the patient did not have the correct medical diagnosis.

Keyboard players with smaller hand sizes are at increased risk for developing overuse syndromes and occupational palsies, including de Quervain's syndrome (Sakai et al., 2006). Small-handed keyboard players have to play with a greater abduction angle of their thumbs, which increases the risk of developing de Quervain's syndrome (Sakai et al., 2006). In a study of 200 Japanese pianists, 35% of the players developed overuse problems. In 74% of all cases the pain was attributed to practicing octaves and chords (Sakai, 1992, 1993, 2002). Brown identified a direct correlation between awkward postures of pianists and wrist injuries (Brown, 2000). Paying much attention to postures of musicians is critical (Lister-Sink, 1993, 1994). In keyboard playing excessive thumb abduction is often combined with maximum radial deviation (Sakai et al., 2006).

In spite of the patient being at increased risk, the diagnosis of de Quervain's syndrome did not match the physical findings of the physiotherapy examination. For example, the patient's thumb strength was well within normal limits. Studies of strength measurements in de Quervain's syndrome have demonstrated significant loss of strength (Fournier et al., 2006; Forget et al., 2008). Active thumb range of motion was increased, while in persons with de Quervain's syndrome, active range of motion is usually decreased (Forget et al., 2008). The increase in range of motion may be a functional adaptation, as sometimes is seen in musicians, but it is nevertheless inconsistent with a diagnosis of de Quervain's syndrome (Ackermann and Adams, 2003).

In 1895, Swiss physician Fritz de Quervain first described the disorder, which later became known as de Quervain's syndrome (de Quervain, 1997; Ahuja and Chung, 2004). The syndrome is usually defined as pathology of the tendons of the extensor pollicis brevis and the abductor pollicis longus muscles secondary to stenosis of the first dorsal compartment of the wrist. The Finkelstein test, during which the clinician grasps the patient's thumb and quickly deviates the hand and wrist ulnarly, is the classic diagnostic test for de Quervain's disease. The Finkelstein test was first described by surgeon Harry Finkelstein in 1930 (Finkelstein, 1930). A few years earlier, Eichhoff described a similar test for de Quervain's syndrome in 1927 (Eichhoff, 1927). Many clinicians erroneously refer to Eichhoff's recommendation to place the thumb within the hand and subsequently bring the hand into ulnar abduction as the Finkelstein test. Interestingly, recent biomechanical analysis has shown that the Finkelstein test has a bias toward the extensor pollicis brevis tendon over the abductor pollicis longus, and it was suggested that de Quervain's syndrome may in fact be a pathology of the extensor pollicis brevis tendon and subsheath (Kutsumi et al., 2005). Surgical releases of the subsheath have resulted in complete relief of symptoms (Louis, 1987). Physiotherapy intervention following surgical intervention has been shown to be important and effective (Robinson, 2003).

The differential diagnoses for de Quervain's syndrome include a scaphoid fracture, osteoarthritis of the carpometacarpal joint of the thumb, Kienbock disease, and Wartenberg's syndrome. Kienbock disease is characterized by wrist pain, sclerosis and collapse of the lunate due to avascular necrosis. Wartenberg's syndrome, sometimes referred to as cheiralgia paresthetica, is an entrapment of the sensory branch of the radial nerve (Carlson and Logigian, 1999). The patient had no history of falls or other trauma, which increased the likelihood that she could have a superficial radial neuropathy or Wartenberg's syndrome. The patient had increased pain with ulnar deviation and pronation of the forearm, which supported the diagnosis of Wartenberg's syndrome (Carlson and Logigian, 1999).

Some authors have suggested that Wartenberg's syndrome and de Quervain's syndrome may be correlated (Rask, 1978). Lanzetta and Foucher emphasized the importance of identifying Wartenberg's syndrome before performing a surgical release of the first dorsal compartment to avoid poor surgical outcome, aggravation of neuritis, and potential legal action against the surgeon (Lanzetta and Foucher, 1993). Rask maintained that superficial radial neuritis may actually be the result of contiguous inflammation of de Quervain's disease (Rask, 1978). Patients with superficial radial neuropathy or Wartenberg's syndrome often present with numbness or pain over de dorsolateral aspects of the hand, wrist and thumb, and the index, middle, and ring fingers (Plancher et al., 1996; Fontes, 2004). Some patients experience a poorly localized burning or shooting pain into the dorsum of the thumb, first web, or index finger (Eaton and Lister, 1992). At the recommendation of the physiotherapist, a neurologist confirmed the clinical diagnosis of Wartenberg's syndrome.

To better direct the physiotherapy program, it seemed important to investigate the cause or causes of the nerve entrapment. Superficial radial neuropathies can be caused by nerve entrapment in the forearm, wrist, or in the distal nerve branches in the hand. The site and nature of entrapment determine the therapeutic intervention. Some patients presenting with compression of the radial nerve are relatively easy to treat, by removing the compressive agent (Rask, 1979; Plancher et al., 1996). For example, when a tight wristband causes sensory radial nerve entrapment, the treatment would consist of removing the band (Rask, 1979; Plancher et al., 1996). Entrapments in the forearm are more challenging. One possible entrapment site is in between the two slips of a split brachioradialis tendon, which was observed in 5 out of 150 dissected arms in 4 out of 74 cadavers (Turkof et al., 1994). An in-vivo study of patients with Wartenberg's syndrome found this kind of entrapment in 7 out of 143 patients (Turkof et al., 1995). Other entrapment sites at the elbow include compression underneath an accessory brachioradialis muscle (Spinner and Spinner, 1996a), in between the tendons of the brachioradialis and extensor carpi radialis longus (Kleinert and Mehta, 1996), or as the result of surgical tendon transfers (Spinner and Spinner, 1996b). Because the Finkelstein test was negative when performed with the patient's elbow in extension, the possibility of a nerve irritation secondary to stretch could not be excluded. The role of the observed myofascial trigger points seemed relevant as well. Trigger points have been associated with nerve entrapments and it seemed conceivable that taut bands and trigger points in the brachioradialis and extensor carpi radialis longus muscles could potentially contribute to nerve compression (Dommerholt et al., 2006a,b). The referred pain patterns of trigger points in the right infraspinatus, supraspinatus, medial scalene, brachioradialis, supinator, and extensor carpi radialis longus muscles do include the area of the pain complaint, even though the pain was not elicited with palpation (Simons et al., 1999). The possible contributions of latent trigger points are still largely unknown (Lucas et al., 2004; Lucas, 2008). Although the exact location of the nerve entrapment could not be identified, a physiotherapy treatment plan was developed and implemented.

Following the Guide to Physical Therapy guidelines, the patient's sensory radial nerve entrapment was considered her primary pathology. Her impairment was pain. Her functional limitation was not able to play organ or piano without pain. The patient was clearly disabled as she was not able to meet the demands of her job. The patient was categorized into musculoskeletal practice patterns B (Impaired Posture), C (Impaired Muscle Performance), and neuromuscular pattern F (Impaired Peripheral Nerve Integrity and Muscle Performance Associated with Peripheral Nerve Injury) (American Physical Therapy Association, 2001).

The first step in treating this patient was explaining why she could not possibly have de Quervain's syndrome, even though three orthopedic surgeons had made that diagnosis. She needed to understand that surgery of the first dorsal compartment would most likely not resolve her pain and restore her function. Instead, physiotherapy consisted of soft tissue mobilizations of the muscles around the elbow, including the brachioradialis, supinator, and wrist extensor muscles. Myofascial trigger points were treated with a combination of trigger point dry needling and manual trigger point therapy. She was instructed in gentle nerve gliding exercises for the radial nerve within a pain-free range. After six sessions of physiotherapy twice per week, the patient started noticing a modest improvement. She was instructed to start playing piano again, but only during 5—10 min per day. According to the patient, playing piano was less involved than playing the organ.

A friend of the patient took photographs while she was playing the piano and organ to allow the physiotherapist to evaluate playing her playing postures. At that time, the physiotherapy clinic did not yet have a piano at the premises. The photographs were reviewed with the patient. She presented with poor posture at both instruments with the same postural problems identified during the initial evaluation. The organ is particularly challenging from a postural perspective. Organ players use their feet and their hands and balance their trunk on the bilateral ischial tuberosities, which makes it difficult to keep the trunk aligned in a spine neutral position. The focus of the physiotherapy program changed slowly from the pain management phase to the conditioning phase with more emphasis on proper posture, correction of forward head posture, core stabilization, and functional training to reduce disability. During the pain management phase, reduction in pain is the main objective and physiotherapists may employ manual therapy, dry needling (where legally allowed), electro-therapeutic modalities, and emphasize the basics of posture training and early improvement in physical functioning. During the conditioning phase, the focus shifts to advanced exercises and training to further improve physical function and reduce disability (Dommerholt, 2005). Musicians must learn that successful rehabilitation requires self-pacing during activities, for example when the musician returns to playing the instrument, and setting appropriate and achievable goals, including physical, functional, and social goals (Norris and Dommerholt, 1995; Harding et al., 1998). The patient was instructed in proper practice habits, emphasizing regular and frequent breaks, shadow-playing, mental practice, relaxation, and visualizations of the music.

Physiotherapy was continued for a total of four months at which point the patient was nearly pain-free. She rated her pain as a "1" on a visual analog scale ranging from 0 to 10, with "0" being equal to "no pain" and "10" the "worse level of pain she could imagine." She had no pain with activities of daily living and was able to play the organ and piano. Several months after being discharged from physiotherapy, the patient pursued her dream and started her graduate studies in organ. Two years later, she graduated from the program with a master's degree in organ. Since her graduation, she returned twice to physiotherapy for other non-related musculoskeletal problems. By her own report, she never experienced the pain in her wrist and thumb again.

In summary, this patient was diagnosed incorrectly with de Quervain's syndrome. Instead, based on the physiotherapy examination she was eventually diagnosed with a sensory radial nerve entrapment. Even though the actual entrapment was not identified, the physiotherapy treatment regimen was very successful and returned the patient to full function. Not only was she able to meet the demands of her job, she was able to complete graduate studies in organ.

Summary and conclusions

Physiotherapists are essential providers in the field of performing arts medicine. As illustrated by the case reports, physiotherapists can play a substantial role in the prevention, diagnosis, and management of performance-related musculoskeletal injuries of musicians. The case reports of the guitarist and organist illustrate that patients may not always have the proper medical diagnosis. The guitarist presented with myofascial pain and dysfunction, but was previously diagnosed with ''scar tissue.'' The organist was almost exposed to surgical correction of a presumed de Quervain's syndrome, which she did not have. The case reports of the bassoonist and guitarist highlight particular ergonomic challenges. Through specific individualized instrument modifications both musicians were able to return to playing their instruments.

Other ergonomic measures within the scope of physiotherapy practice may include the evaluation of orchestra chairs, which often are poorly designed and not suitable for the task. Musicians often have musical instruments that do not match their anthropometry, as illustrated in the guitarist and bassoonist's case reports. Many string instruments, including violins and guitars, are available in different sizes, which should be considered as part of injury prevention and treatment programs (Kopfstein-Penk, 1994). Familiarity with musicians' backgrounds, musical instruments, and work conditions is helpful and clinicians who do not have a musical background may need to develop the necessary skills and knowledge (Wagner, 1995).

Few publications have documented the actual physiotherapy treatments of musicians (Warrington, 2003; Winspur, 2003). This article included three case reports, but more systematic research is needed to determine the outcome of physiotherapy intervention in the treatment of musicians. Physiotherapists interested in treating musicians can start with expanding the history component of the initial evaluation as outlined in part I of this article series. By asking specific questions about the instrument, practice habits, education, repertoire, and employment much pertinent information will direct the physiotherapist and musician toward a solution of otherwise career-threatening injuries. In the end, attending concerts by former patients, who at one time were convinced that their musical careers has ended due to injury, is one of the most gratifying outcomes of performing arts physiotherapy.

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