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Phys Med Rehabil Clin N Am
17 (2006) 803–811

PHYSICAL MEDICINE
AND REHABILITATION
CLINICS OF
NORTH AMERICA

Dance Medicine: Current Concepts

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Dance medicine has grown exponentially over the past 10 to 15 years and continues to grow every year as more former professional dancers and students of dance enter into the field of medicine. Dance medicine is part of the field of performing arts medicine, which specializes in evaluating and treating performing artists such as musicians, dancers, actors/actresses, and vocalists. There are many different physician specialties involved with this field, including physiatrists, neurologists, orthopedists, rheumatologists, otolaryngologists, and psychiatrists along with physicians of internal medicine, family medicine, and occupational medicine. There are also many different allied health clinic professionals involved with treating these artists, including physical and occupational therapists, chiropractors, acupuncturists, nutritionists, and practitioners of Pilates, Feldenkrais and Alexander methods. In addition, there are many different forms of dance, including classical ballet, modern, jazz, tap, flamenco, folk dance, and ballroom dancing. Classical ballet originated in Italy during the Renaissance period and continued to flourish when taken to France by Catherine de Medici. This form of dance was an outgrowth of three popular pastimes of the nobility, including fencing, dancing and horsemanship. Dancing on pointe (on the toes) began in the early 1800s. This technique has separated classical ballet from all other dance forms both technically and medically. This article reviews the literature on dance medicine for various health-related medical issues, for the types of injuries commonly found, for the common surgical and rehabilitation interventions, and for injury prevention used in this unique group of patients.

The art of dance, particularly ballet, is one of the most physically demanding activities on the musculoskeletal system. Most literature and medical treatments focus on professional classical ballet and professional modern dance probably because of the high injury rate. Sixty-seven percent

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1047-9651/06/$ - see front matter
doi:10.1016/j.pmr.2006.06.005

to 95% of the company dancers per year average approximately 1.7 to 6.7 injuries per dancer per contract year [1–4]. Overuse injuries remain the most common type of reported injury, with the highest incidence in the foot and ankles followed by the hip, lumbar/thoracic/cervical spine, and then knee/leg [1–6]. This is because of the sheer nature of their physical activity. Dance classes can last up to 1.5 hours followed by rehearsals that can last up to 5 hours. The dancer's body can be exposed to a highly physical demanding activity for greater than 6 hours per day. Many dancers also may have only 1 day of rest per week. In addition, the workload increases during beginning of a performance season such as the Nutcracker, which is performed the most each year (as many as 30 performances), or when returning to work after a relative time off from dance [3]. Age and gender do not appear to increase the risk for injury, which appears more related to high-level physical demand on the individual [7]. Thus, injury prevention has focused on educating the performer, teachers, and staff to modify activity levels to allow for adequate rest and recovery time for the dancer's body.

Most of the literature on dance injuries comes from studies on professional companies. There are some published studies on the students of dance from various performing arts schools showing differing injury rates per school year, from 47.3% by the Robson study [8], 49% by the Hamilton study [9], and 19.5% by the Miller study [10]. These studies found that nonmusculoskeletal health-related problems of stress and anxiety were reported as having a significant negative effect on performance. These psychosocial stressors were shown to have an adverse effect on the dancer physically and to contribute to a higher injury rate. Dancers who undergo psychosocial stress-related interventions have been shown to have less physical injuries and increased recovery from injuries [11,12]. This is an emerging field of medicine focusing on treating the psyche. Further research is needed to advance this area of intervention for injury prevention and treatment of injuries in dancers.

Another important health-related issue includes the female athlete triad, which needs to be considered in the young dancer because of the higher prevalence of late menses in this group. Today's classical ballet dancer is at least 20 lbs lighter than her counterpart of 40 plus years ago. Thinness is considered desirable aesthetically for the female dancer. Such focus easily leads to eating disorders, and medical practitioners often overlook the nutritional needs of their patients. Several Studies show that at least 6.5% of the female dancers suffer from eating disorders such as anorexia and bulimia, and up to 22% suffer from other nonspecified eating disorders [13,14]. This is followed by amenorrhea and osteoporosis that collectively are known as the female athlete triad. The incidence is around 15% to 65% in athletes [15–17]. A similar rate has been found in female dancers [18]. The long-term effects of developing osteoporosis in younger women are serious, because they will deal with the complications of osteoporosis the rest of their lives. In addition, there is evidence that the risk of developing

scoliosis occurs with the female athlete triad [19]. The female dancer has many of the common characteristics of the female athlete triad, which includes perfectionist personality, highly competitive, self-critical, lean physique, stress fractures without a change in activity, and recurrent stress fractures and young age. Early detection and intervention of these emerging characteristics is extremely important for injury prevention and health maintenance of the female dancer.

Many other factors contribute to dance injuries, including foot morphology, the dancer's physique, dance floor surfaces, footwear, training and technique errors, and poor nutrition [20–24]. Because these art-specific factors are not taught in medical schools or included in a typical rotation of a residency training program, the health care provider who wants to treat dancers really needs to have a good foundation of knowledge in this art form. This includes understanding ballet and dance technique, the language of dance, the psychosocial stress of this field, the specific health-related issues of this field, and the working situations of this field. Former dancers who have gone into medicine or the health care field have helped to bring their knowledge of the arts to the field of medicine. Physiatry, sports medicine, and orthopedics help provide the musculoskeletal medicine basis for treatment of dancers. The physician who does not have a dance background has to learn these other aspects of dance medicine through continuing education programs offered at arts medicine conferences, by studying the arts medicine literature, by working with dance teachers and dance educators, and by doing clerkships at the various arts medicine clinics.

Dance is a mix of art and athleticism, and dancers possess unique physical and anatomical qualities. They require specific flexibility and strength qualities of the body that are unique to the art form. Dancers are hyperflexible but not necessarily hypermobile [1,25,26]. Their flexibility is important to perform the classical ballet technique. For example, in order for female dancers to do pointe work (dancing on their toes with a supportive shoe), they require 90° of plantar flexion and 45° of great toe dorsiflexion [2,21,27]. Dancers require hip external rotation greater than 45° for adequate turnout, as 60% of turnout occurs at the hips, and 40% occurs from the knees and feet [2,28]. Dancers who are hypermobile are more injury prone, as the ligamentous laxity places increased demand on the stabilizing and supporting structures of the body's joints.

Increased flexibility comes from years of stretching the hamstrings and the spine both in extension and flexion. They do not necessary have increased hip range of motion as compared with nondancers, but they do have increased flexibility in the knees and feet [2,21,25–28]. All of these characteristics need careful attention during the evaluation and treatment of dancers.

Most of the research has documented the foot and ankle complex as the most commonly injured site in the dancer. Several foot pathologies can be seen mostly in female ballet dancers because of their pointe work. These pathologies include hallux valgus, claw toes, hammer toes, bone spurs, stress

fractures (metatarsals most common), corns, and calluses. The metatarsal stress fractures usually involve the second metatarsal and occasionally Lisfranc's joint [29,30]. This joint is formed by the medial and lateral cuneiforms that surround the base of the second metatarsal, locking it into place, which increases stress to this bone. Traumatic fractures also occur, including the Jone's fracture and short oblique (dancer's) fracture [31]. The best foot morphology for the dancer is the peasant foot, where the first three toes are equal length along with a flat forefoot and sturdy arch. The Grecian (Morton) foot with the short first ray increases the dancer's risk of second metatarsal stress fractures. Other foot and ankle problems encountered include sprains, Achilles tendonitis, flexor hallucis tendonitis, plantar fasciitis, anterior and posterior impingement syndromes of the talus, and Os trigonum [32,33].

The most common knee injuries tend to be patellofemoral syndrome or anterior knee pain. Jumper's knee, shin splints, and subluxing patella follow in frequency. Traumatic injuries such as anterior cruciate ligament, medial collateral ligament, and meniscal and lateral collateral ligament tears occur, but less frequently. In the hip, dancers often complain of pain and clicking while performing develop (lifting the leg to above 90° of flexion or abduction). This can be caused by a mechanical issue of the iliofemoral ligament (Bigelow) or tendons of the iliopsoas and rectus femoris with the lesser trochanter. In addition, iliopsoas tendonitis/apophysitis or less commonly rectus femorus tendonitis/apophysitis can be potential causes for this condition. Thigh or groin strains commonly occur also. Less common are avulsion fractures of the sartorius and rectus femorus origins.

Low back pain in the dancer usually derives from muscular strains, but, because of the extreme hyperlordosis used to extend the spine, dancers have an increased rate of stress fractures of the posterior elements, particularly pars defects or spondylolysis. Spondylolisthesis and disc herniations are rare occurrences.

Dancers are extremely well-conditioned athletes. They have excellent muscle definition because of their low body fat (women less than 15% of ideal body weight) and acquired strength [2]. Their art form demands anaerobic metabolism and aerobic capacity. The strength developed to perform ballet is highly exercise-specific. There is some controversy in the literature as to whether dancers are stronger than other athletes. One study of knee strength showed dancers falling in between athletes and controls, while another study showed no significant difference in knee and foot strength from controls [27]. Methods for measuring strength, however, are not standardized, so drawing significant conclusions is difficult. One thing is certain; a female basketball player does not have the foot strength to do pointe work, and the female ballet dancer does not have the aerobic endurance to play a basketball game. This emphasizes the need to provide exercise-specific rehabilitation or strength conditioning to achieve the desired physical ability.

Because of the multiple facets of dance medicine, treating dancers has become multi-disciplinary. The arts medicine physician works with the dancer,

parents, teachers, dance educators, surgeons, physical therapists, chiropractors, massage therapists, acupuncturists, and Pilates, Alexander, and Feldenkrais [34] therapists. Pilates has become the most popular exercise form used by dancers. Joseph H. Pilates, a boxer and weight lifter, developed a series of exercises to strengthen the core or body's center of the abdomen and spine. There are a series of floor exercises and machines developed to aid in resistive strength and flexibility training. The reformer, trap table, and chair can be used to rehabilitate dancers after an injury. These machines allow the dancer to perform exercises specific to their ballet technique, both non-weight-bearing and advancing to weight-bearing as tolerated. The addition of a series of springs allows for resistive strength training. The healthy dancer also can use the entire Pilates exercise program as cross-training during their active season and for maintenance of their physical condition on their off seasons. Although there is little published medical literature on Pilates, there is evidence of reduced pressures on the legs and feet with dance-specific exercises [35,36]. Because funding is limited in the arts for medical research, additional studies focusing on Pilates likely will remain limited. Most arts medicine specialists, physical therapist clinics, and ballet companies, however, already generally have accepted Pilates as a standard of care and have incorporated this exercise therapy form into their practices.

Other forms of rehabilitation also exist for dancers, including the Feldenkrias method and Alexander technique. Both forms use imagery and sensory feedback from the therapist and help with muscle relaxation and neuromuscular re-education. Both forms help the dancer to unlearn improper use of muscle functions and rehabilitate the body to use muscles correctly in the proper alignment and technique. More in-depth discussion on these modalities is available elsewhere [21,34].

In general, treatment considerations for most dance injuries typically focus on exhausting all conservative methods with rest or relative rest, ice, heat, nonsteroidal anti-inflammatory drugs, and other analgesic medications. In addition, use of PT modalities such as ultrasound, electrical stimulation therapies, iontophoresis, prolonged stretching, and therapeutic exercises is common. Therapeutic exercises should include dance technique-specific exercises. It also may be necessary to work with dance teachers to help modify ballet technique and work habits. The most common ballet technique faults include rolling in of the feet (foot eversion), forcing the turnout at the knees and feet, lifting heels off the floor in plie or when jumping, gripping the floor with the toes, hyperextending the back (sway back), tucking under of the pelvis, and not keeping the knee over the second toe in plie [21,27].

Although the most common types of dance injuries include overuse syndromes, traumatic injuries can occur. Dancers usually sustain sprains, strains, tendonitis, bursitis, and stress fractures. Other less common injuries include internal derangement of the knee injuries such as anterior cruciate ligament (ACL) tears and meniscal tears, along with tendon ruptures and disc herniations. The incidence of these types of injuries is reported as very low, with an

average of five per year over 3 years [37]. Surgical options are typically the last resort for most dance injuries. The most common are those for traumatic type of injuries such as ACL tears, meniscal tears, tendon repairs (Achilles), tendon debridements (flexor hallucis longus) [33,38], removal of bone spurs, and occasional spine surgery for a disc herniation. Again, it is important to find surgeons who are familiar with the dancer's body and dance technique needs. Surgery and postoperative rehabilitation need to maintain or restore the dancer's unique range of motion and strength for full functional return to his or her particular art form. Pilates and pool therapy are useful tools in helping restore function of the dancer after surgery.

After reviewing all these injury characteristics of the dancer and their dance-specific interventions, one of the main goals of dance medicine over the past several years has been injury prevention. This has become a main focus for the future also. Injury prevention is important to pursue at an early age with the dancer, even at the grade school level, and it should continue throughout the dancer's career. Even with today's knowledge of the published literature on dance medicine, many ballet schools and touring ballet companies do not have optimal conditions that would help to prevent injuries. They do not have correct floor surfaces or teach the correct dance technique. Additionally, they have inadequate warm-up space. Even large touring music theater productions such as the Phantom of the Opera, which uses dancers with ballet technique, face the same suboptimal conditions to help protect the dancer from injury. Many of the theaters on these tours are not designed for the dancers' physical needs. Because of these issues, modification of activities and environment is important for the dancer to learn. The following tips can help:

- Proper warm-up/cool-down before dancing. Dancers can use heat to warm up muscles/tendons and gently stretch calves, hamstrings, quadriceps, hips, and low back. Do for 5 to 10 minutes. Prolonged stretches greater than 30 seconds after class for all muscles. Ice sore areas 20 minutes or 5 minutes of ice massage.
- Muscle soreness that goes away after 5 to 10 minutes is okay. Pain lasting longer may lead to injury. Sharp pain or persistent pain may indicate possible injury requiring rest and medical attention.
- Avoid hard dance surfaces or obtain proper sprung flooring.
- Proper fitting footwear and possible inserts/shoe modifications
- Proper nutrition (includes 1200 mg calcium with 800 U vitamin D for females)
- Proper ballet technique. Avoid rolling in off feet; do not force turn-out. Keep heels on the floor in plie; do not grip floor with toes. Do not hyperextend the back (sway back); do not tuck under pelvis. Keep the knee over the second toe.
- Avoid recreational activities that may add stress to the body.
- Counseling for stress management and eating disorders

Additional data on the student dancer level and professional dancer level would help tailor these preventive measures. Few published studies scientifically document if these preventative dance medicine measures help reduce dance injuries. It has been shown that injuries can be reduced (and medical insurance premiums) for a professional ballet company with a self-insured and company-based medical clinic on site [3]. The feasibility of replicating this type of system with other professional dance companies and ballet schools remains to be determined. More research is needed on the outcomes of preventative medicine for dancers. Comparing these outcomes with previous published research will help dance medicine specialists gain better insights on what preventative measures actually work for the entire field of dance.

Future considerations

Because of the numerous groups of professionals involved with the care of the performing artists, various arts medicine organizations have been developed around the world for the sharing of research, education, health maintenance/prevention, and developing common practice guidelines. Some of these organizations include the Performing Arts Medicine Association, (PAMA, United States), the International Association for Dance Medicine & Science (IADMS, United States), the British Arts Medicine Association (BAMA), the German Performing Arts Medicine Group (GPAMG), the Italian Performing Arts Medicine Group (IPAMG), and the National Dance Association (United States). These organizations combine memberships from all professionals in the field of arts medicine and have yearly conferences. Most have Web sites accessible by common links found on the Web site of www.artsmed.org. The dance medicine field needs to do a better job of standardizing research approaches to better quantify therapeutic techniques and injury prevention outcomes. This information is vital to the future for providing the highest quality of care for this specialized field of medicine. The Internet is a useful research tool, and it is being developed to provide communication around the world with arts medicine specialists. Hard-to-find arts medicine literature also can be found through these sites. Further development of preventative medicine techniques and education/health promotion is needed to pursue further areas, including nutrition, substance abuse, HIV, dance floors, protective footwear, activity modifications, and training errors. The dancers and their educators need to play active roles by following injury prevention and health promotion guidelines, along with helping to direct health care providers to their specific needs.

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