Tender Loving Care for Dancers' Legs

Understanding, preventing and treating injuries in Scottish Country Dancers

by Keith Eric Grant

Introduction

It seems to happen too frequently. You were in the middle of an incredible workshop on the techniques and art of Scottish Country Dancing. Suddenly, you are sidelined with an injury that has traded your ghillies or dance pumps for an icebag and moved your feet into an elevated position. The immediate questions asked are, "Why me?" and "Why now?" Later, come the follow-up questions of how to heal this injury and prevent the next one from ever occurring.

In this article, I hope to answer these questions, not only for the individual Scottish Country dancer, but for the dance teacher planning classes and for the massage practitioner working with these dedicated and congenial dancers. To attempt to briefly describe Scottish Country Dancing (SCD) for the non-dancing body-worker is a daunting challenge. For SCD enthusiasts (and what dancer isn't?), discussion is the mill stone used with delight to grind every nuance of steps, technique, music, and social interaction into a fine flour indeed. Yet it is the resulting consensus on the techniques and emphasis on interaction that continue to make SCD the international dance form that it has become. SCD is characterized by repeating patterns of figures danced in sets of four couples, arranged in two parallel lines. Particularly relevant to our purpose here, it is a dance form executed wearing thin, flexibly soled ghilles or dance pumps and performed with an emphasis on turned-out (laterally rotated) hips and pointed (plantar flexed) ankles and feet. Rarely do the heels of the dancer bear weight during the course of a dance. Riding upon the formalized SCD styling, lies the dynamics of the dance and the joy and excitement of the dance in relation to the music and the musicians.

Muscles and Connective Tissue

To understand how injuries result from the strains of dancing requires a basic knowledge of the structure and roles of muscle and connective tissue that compose and shape our bodies. The ability of muscles to contract and lengthen is responsible for most of the movements of the body. These range from the smallest adjustment in the diameter of a tiny artery, to the broadest expressive gestures. Muscles are the body's primary energy consumers. When dysfunction alters the mechanical efficiency of the muscle-skeletal system, activity requires a greater amount of energy. Muscles are arranged in bundles of fibers, each acting independently of its neighbors. Only the number of fibers needed to perform an action are brought into play at any time. Fibers either contract to their fullest or do not contract at all. As muscle fibers or groups fatigue past their level of conditioning, continued activity results in recruitment of additional fibers. This often results in less optimum biomechanics or use of inadequately conditioned muscles.

Connective tissue includes the fibers and fascial sheets that support and bind other tissues and parts of the body. Fascia is pervasive throughout the body, wrapping each scale of organization from individual muscle fibers to entire groups of muscles and organs. Collagen fibers of connective tissue form both the tendons that connect muscle to bone and the ligaments that bind joints together. Connective tissue becomes more fluid when it is stirred up, and more solid when it sits without being disturbed. Immobility or trauma can accelerate the tendency of collagen fibrils to glue together into nodules and adhesions. Such gluing can often be addressed and ameliorated by deep massage designed to break adhesions and free chronic patterns of tissue holding.

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When we talk of injuries, we are talking mostly about strains of muscle-tendon units or sprains of ligaments. Such tissue injuries are graded from mild to severe (one to three) depending on the amount of tearing and the resulting limitations in movement and weight-bearing. Most muscle strains occur, not in the muscle belly, but in either the junction between muscle and tendon (myotendinous junction) or where the tendon attaches to the periosteum, the living lining of the bones (tenoperiosteal attachment). Most injuries will result from inadequate warm-up, inadequate conditioning or sudden increases in the amount of dancing (e.g. workshops), or chronic overuse that eventually compromises tissue healing and structure. All of these modes will be affected by the biomechanical weaknesses, age, and injury history of the individual dancer.

Warming Up and Cooling Down

One of the simplest ways of reducing dance injuries is to warm up the muscles and connective tissue before beginning vigorous, weight-bearing dancing. A warmup should consist of a minimum of 10-15 minutes of activity sufficient to elevate body temperature without causing fatigue. SCD warmups should include general movements of all large muscle groups and the specific movements encountered in dancing. The range of motion (ROM) over which the movements are done should be limited at first and increased as tissue temperature rises. By the end of the warmup, the entire ROM needed to dance should have been exercised. A warmup should not, however, include stretches attempting to increase a dancer's flexibility and maximum ROM. To include such stretches before the tissue is deeply warmed is to invite connective tissue injury. Stretching to increase flexibility should either be done during cool-down, or be done (after a warmup) at times separate from dance classes. Dancing, ideally, should begin within 15 minutes of ending the warmup. The beneficial effects of a warmup are lost after 45 minutes of rest.

Warming up produces many mechanical and neurological effects that increase the body's ability to react quickly to stimuli and to dance longer without fatigue. As connective tissue warms, it becomes more elastic and easier to stretch. This is a major physiological reason to postpone aggressive stretches until tissue is thoroughly warmed at all depths. Movement stimulates production of joint lubricating synovial fluid. This fluid becomes less viscous as it warms with continuing movement. Blood flow to the muscles and the exchange of oxygen increase. The rate of neuromuscular transmission and recruitment of muscle fibers increases. The (reciprocal) relaxation of a muscle as its opposing muscles (antagonists) contract becomes more efficient. The neuromuscular memories specific to SCD are activated. In total, the changes occurring during the warmup greatly increase the ease of dancing and substantially decrease the likelihood of immediate injury.

A cool-down period of 5-10 minutes should follow the last dance. Continuing with fewer strenuous movements helps remove metabolic wastes from muscles and allows the dancer's heart rate to gradually decrease below 100 beats per minute. It also helps to reduce hypertonicity (spasm), increasing the rate of return to homeostasis. Flexibility stretches can be done at this time, since muscle fibers and connective tissue are thoroughly warmed and maximumly elastic. Regular stretching helps to maintain or increase the length of muscle-tendon units that otherwise tend to shorten to the maximum length over which they are regularly used. Two major options are static stretching and active isolated stretching (AIS). Both types of stretching are done only to the point of light discomfort or irritation. Static stretches are held for approximately 30 seconds. This takes advantage of the slow viscous elongation of connective tissue. AIS stretches are initiated by contracting the muscles opposing the muscle to be stretched. The stretch is held for only 2 seconds followed by a 2 second rest. The short duration of the stretch avoids triggering and working against the contraction of the stretch reflex. Stretches are generally done in 2-3 sets of 8-12 repetitions, often with the assistance of a stretch strap or rope.

Conditioning

Sufficient conditioning is achieved by a gradual buildup in the duration and intensity of dancing. A general rule off sports training is that the total activity increases by no more than 10% per week. The individual requirements for specific dance conditioning will vary with a dancer's age and other activities. The greatest age related factors are decreased tensile strength and elasticity of connective tissue. Weight and resistance training exercises (e.g., against elastic surgical tubing) are useful for keeping opposing muscle groups in balance. An example would be resisted ankle dorsiflexion (upward movement), when the plantar-flexors such as the

Illustration: Elizabeth Ann Sufit

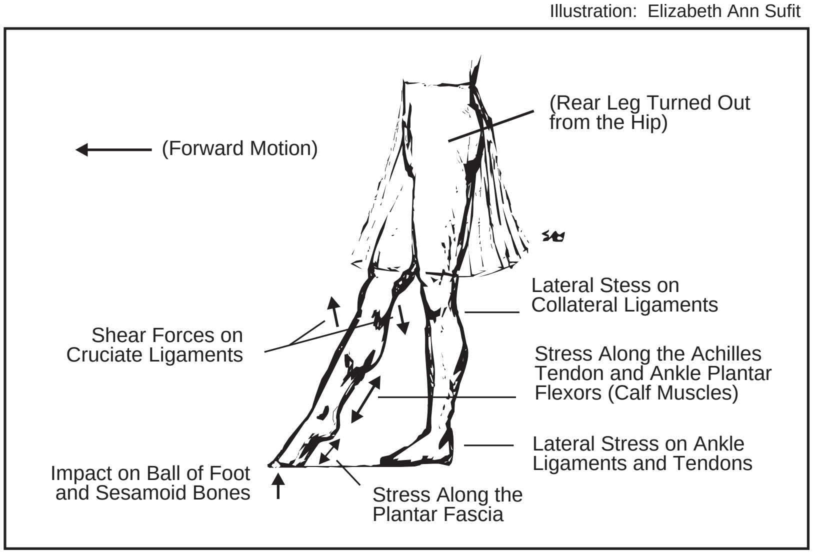

Figure 1: Sideview of Scottish Country Dance forward weight transfer with key areas of stress indicated

gastrocnemius and soleus are preferentially used in dancing.

To be successful in preventing injury, hardening exercises need to be specific to the stresses encountered in SCD. Exercise physiologist Owen Anderson notes that the greatest strain on the Achilles tendon and plantar flexors during running occurs just before and during the footfall. The resulting stress includes both eccentric (resisted lengthening) and rotational components. He concludes that exercises to protect and strengthen the Achilles tendon must be designed to specifically replicate these stresses in a more gradual and controlled manner. As I will point out in more detail below, similar stresses occur in SCD dancing as the extended foot takes weight during a forward step. The conditioning requirements are also similar — replication of the stress in a reproducible and controlled exercise.

Stress Analysis of a Forward Scottish Country Dance Step

To illustrate the injury modes specific to Scottish Country Dancing, I have chosen to examine the stresses occurring during a typical forward step. As is characteristic of SCD, the hips are turned out (laterally rotated), weight is initially on the ball of the rear foot, and the front leg is extended forward with the ankle pointed (plantar flexed) and the front foot slightly inverted (sole inward). This position is shown in Figures 1 and 2. Greater detail of the forward ankle and foot is shown in Figure 3.

Due to the turned out rear hip, the forward push for the step initiates from the abductors of the hip rather than from the extensors. With the weight on the ball of the rear foot, part of the push will also come from the sole of the foot turning outward (everting) and the ankle thrusting downward (plantar flexing). As an evening of dance progresses and muscles tire, the frequent resisted ankle eversions can result in overuse of the peroneal muscles.

Illustration: Elizabeth Ann Sufit

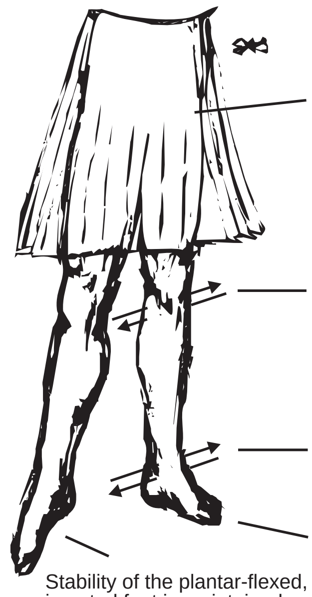

Figure 2: Frontal view of Scottish Country Dance forward weight transfer with additional key stresses indicated

Drawing on my background as a physicist, I'll note that every force exerted will have an opposing reaction force. As the dancer pushes to the rear against the floor, the floor effectively exerts a reaction force forward against the dancer. From the perspective of the rear leg, the lateral force initiating from the hip abductors is balanced by the medial force originating at the floor. This sets up the shear forces across the knee and ankle shown in Figure 2. While not of themselves sufficient to cause injury, these shear forces can become problematic as tiring muscles reduce the actively maintained stability of the rear ankle and knee. This is especially true if the dancer has previously suffered injury to the collateral ligaments of the knee (Figure 4) or to the lateral ligaments of the ankle, notably the anterior talofibular ligament (Figure 3).

Now let's turn to the forward leg, just as it begins to land and take weight. The downward weight of the upper leg is countered at the knee by the force transmitted upward from the foot against the floor. This produces a shear force at the knee similar to the anterior drawer test used to assess a torn anterior cruciate ligament (Figures 1 and 4). We can expect this to be a challenge for the dancer with a prior ACL injury, especially during the extended duration of the position during a slow, reaching strathspey.

We now move down to the ankle (Figure 3), where the foot is slightly inverted (sole inward) and the toes pointed. Even at this stage of the step, if the foot was pointed too enthusiastically as it was brought forward, a strain at the attachment of an inadequately warmed-up big toe extensor (hallucis longus) could have resulted. The foot and ankle must adjust to take weight. Plantar flexion is reduced somewhat in a controlled, eccentric, contraction, a potential

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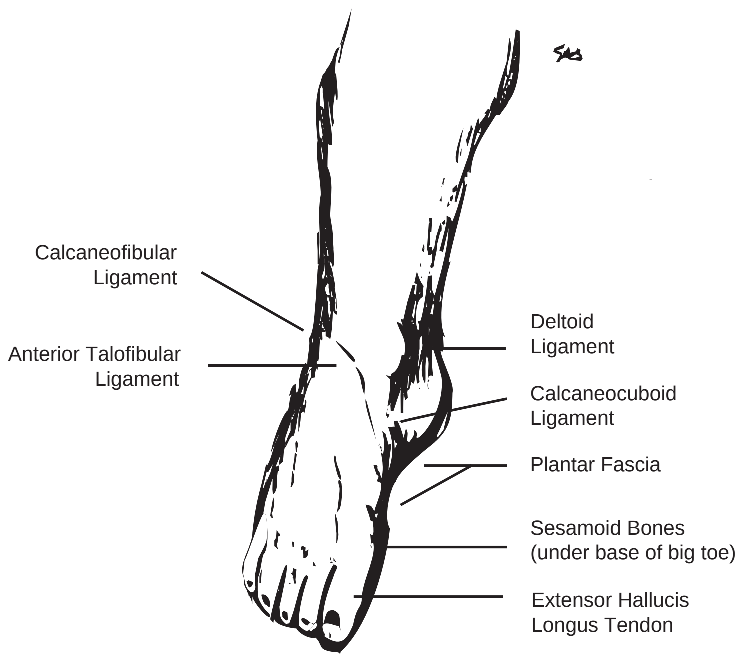

Figure 3: Stress points on the foot and ankle as the dancer's foot begins to land and take weight (customary dance pumps or ghilles omitted to better depict anatomical detail)

strain on the Achilles tendon. The foot will evert to neutral, a controlled eccentric contraction of the tibialis posterior, a culprit in shin-splints (medial tibial stress syndrome). Finally, the toes extend, allowing the weight-taking impact to occur on the ball of the foot; right on the sesamoid bones under the big toe. The plantar fascia and Achilles tendon bear the load to support and maintain this position. If the evening is late and muscles are tired, maintaining ankle stability during weight-taking becomes more difficult. This means increased chances for a foot-fall resulting in an ankle sprain.

For the adequately warmed up, well-conditioned dancer, none of these movements may pose a bio-mechanical hazard. However, problems can arise as fatigue sets in and muscle control wains during an extended SCD dance or workshop. I believe the analysis above points out a number of potential problem areas for teachers and individual dancers to be wary of before the ice-pack is required. Protection from both ankle and knee injuries lies in prior conditioning. This particularly implies strengthening of stabilizing muscles such as the hamstrings, quadriceps, peroneals, plantar flexors, and foot invertors via exercises based on eccentric lengthening. Such strengthening, in conjunction with deep tissue massage to break up adhesions and retraining to regain normal sensing of position (proprioception), are particularly important in rehabilitating a prior injury to avoid its reoccurrence.

Injury, Inflammation, and healing

What happens when, despite our precautions, an injury occurs? Trauma may be either sudden or cumulative. Acute trauma is caused by a sudden injury resulting in pain, swelling, redness, and warmth in the affected area. Since the injury disrupts the flow of blood through capillaries, further tissue damage from lack of oxygen occurs almost immediately. Microtrauma is the result of small injuries accumulated by repetitively stressing a muscle group to the limits of its capabilities with inadequate recovery time. Such microtrauma eventually compromises the tissue's structure and ability to heal. Following injury, the healing response progresses through three separate stages. The cellular response to an injury results in mast cells, macrophages, and granulocytes invading the traumatized area. The mast cells release histamine and

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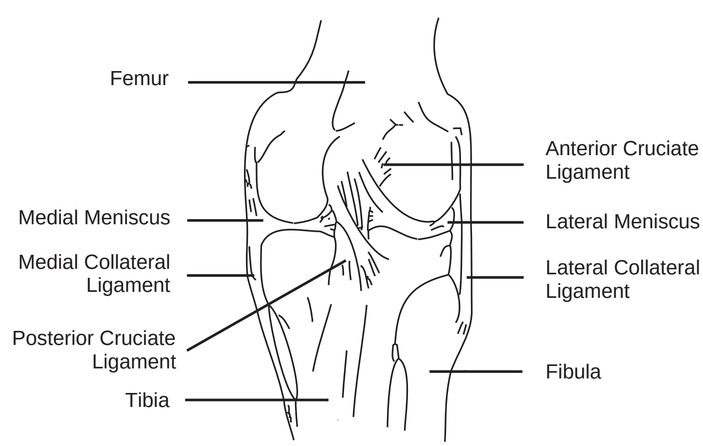

Figure 4: Anatomy of the human right knee as viewed from the back

serotonin, while the granulocytes release prostaglandin, resulting in swelling and inflammation. Cellular response occurs during the first 48 to 72 hours following injury.

Following the first stage, regeneration begins. During regeneration, fibroblasts produce and lay down collagen fibers, without particular regard to the orientation of the new fibers. During the first two weeks after the injury, the tissues may be fragile. Finally, remodeling of the tissue occurs. During remodeling, which can last up to a year for major tissue repair, the collagen assumes its final form. Early mobilization following injury is extremely important. Mobilization discourages the formation of adhesions which would later limit range of motion. Mobilization also provides stresses needed to encourage the organization of scar tissue along parallel lines (Wolfe's law). Local cross-fiber massage can also be a substantial aid in encouraging the flexibility and parallel organization of the final tissue.

Ice, Heat and Alternating Ice and Heat

The immediate actions to take following an injury are given by the mnemonic PRICE. This stands for Protection, Rest, Ice, Compression and Elevation. Ice is applied in the first 48 to 72 hours following the injury. Ice packs (e.g., frozen peas) are applied for approximately 10-20 minutes several times per day. The goal is reduction of swelling, inflammation, muscle spasm, pain, and oxygen needs of the injured tissue. Use caution in applying ice directly to the skin over areas where there is little muscle and subcutaneous fat to insulate nerves. Nerve damage, requiring hours to months for recovery, has occurred when ice was applied for 30 minutes or more directly to the skin of lean athletes.

Ice/Heat Pumping is useful after the first 48 to 72 hours following an injury. Alternating cold and heat applications may be used to increase circulation to the injured area. This helps to reduce inflammation and promote healing. Applications times for each temperature range from 1-4 minutes depending on the location of the injury and the method of application. Each series should always end with a cold application. Heat applications can be used together with massage to relax muscle spasms and increase circulation in chronically injured areas. This is not applicable to chronic-acute injuries (i.e., injuries persisting because of regular reinjury), which should be treated as acute injuries.

Any major or severe injury should be evaluated by a physician. In addition to providing a differential injury diagnosis, the medical system offers guidance and increased choices in using nonsteroidal anti-inflammatory drugs (NSAIDs). The medical system also opens the door to physical therapy exercises and modalities such as ultrasound and electrical stimulation.

Summary

I've tried in this article to review with you some of the basic physiology of muscles and connective tissue. We have looked at how warmups, cool-downs, and stretching differ from each other and how they affect the body. We've examined the role and need for conditioning and rehabilitative exercises. We've looked at specific modes in which Scottish Country Dancing stresses the dancers body. Finally, we've briefly examined injury and healing physiology and some of the nonmedical interventions that can be used to minimize the damage of injury and speed healing. May your dancing days be long and injury free.

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