

COMMON DANCE INJURIES AND TREATMENTS OF THE HIP AND LOW  
BACK: INTERVIEWS WITH PHYSICAL THERAPISTS  
SPECIALIZING IN DANCE

by

TIFFANY ALEXANDRA TAYLOR

A THESIS

Presented to the Department of Dance  
and the Graduate School of the University of Oregon  
in partial fulfillment of the requirements  
for the degree of  
Master of Fine Arts

June 2010

“Common Dance Injuries and Treatments of the Hip and Low Back: Interviews with Physical Therapists Specializing in Dance,” a thesis prepared by Tiffany Alexandra Taylor in partial fulfillment of the requirements for the Master of Fine Arts degree in the Department of Dance. This thesis has been approved and accepted by:

---

Steven J. Chatfield, Ph.D., Chair of the Examining Committee

6/1/10  
Date

Committee in Charge: Steven J. Chatfield, Ph.D., Chair  
Brad T. Garner  
Jane T. Baas

Accepted by:

---

Dean of the Graduate School

© 2010 Tiffany Alexandra Taylor

## An Abstract of the Thesis of

Tiffany Alexandra Taylor for the degree of Master of Fine Arts  
in the Department of Dance to be taken June 2010

Title: COMMON DANCE INJURIES AND TREATMENTS OF THE HIP AND LOW  
BACK: INTERVIEWS WITH PHYSICAL THERAPISTS SPECIALIZING IN  
DANCE

Approved: \_\_\_\_\_  
Steven J. Chatfield, Ph.D.

Through a review of literature and interviews with physical therapists specializing in dance, hip and low back injuries common to dancers are described and options for treatment are discussed. Injuries include internal and external snapping hip, non-specific hip and low back pain, IT band problems, labral tears, hip impingement, and spondylolisthesis. Depending on the site and severity of the injuries, common treatments range from surgical to conservative (e.g. – manual therapy, exercise, Functional Electronic Stimulation, iontophoresis). It is reported that most dancer injuries result from overuse and are related to poor technique. All three PTs interviewed also note that injuries are often a result of choreographic demands on the dancer and recommend breathing techniques and neuromuscular re-patterning for rehabilitation.

## CURRICULUM VITAE

NAME OF AUTHOR: Tiffany Alexandra Taylor

PLACE OF BIRTH: Oklahoma City, OK

DATE OF BIRTH: March 7, 1985

### GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:

University of Oregon, Eugene  
Western Michigan University, Kalamazoo

### DEGREES AWARDED:

Master of Fine Arts, Dance, 2010, University of Oregon  
Bachelor of Fine Arts, Dance, 2007, Western Michigan University

### AREAS OF SPECIAL INTEREST:

Dance Medicine and Science  
Dance Pedagogy, Choreography and Collaboration

### PROFESSIONAL EXPERIENCE:

Graduate Teaching Fellow, University of Oregon, September 2007-June 2010

### GRANTS, AWARDS AND HONORS:

Summer Study Research Grant, University of Oregon, 2009  
Seibert WMU Undergraduate Research and Creative Activities Award, Western Michigan University, 2008

## ACKNOWLEDGMENTS

Many thanks are due to the Department of Dance for allowing me the opportunity to learn and grow as a dancer, choreographer, teacher and scholar. I wish to express sincere appreciation to my mentor and committee chair, Dr. Steven J. Chatfield. To my committee members, Professor Brad T. Garner and Professor Jane T. Baas, for their assistance in the preparation of this thesis. In addition, special thanks are due to Gayanne Grossman, Amy Humphrey and Marika Molnar for their participation and influence in this project. Lastly, thank you to my friends and family for their unwavering support and guidance throughout my time here at the University of Oregon.

This work is dedicated to my mother and father for encouraging me everyday to go for my dreams, try something new, and to never give up.

## TABLE OF CONTENTS

Chapter	Page
I. INTRODUCTION.....	1
Purpose.....	5
Significance of Study.....	5
Definition of Terms .....	5
Interviewees .....	8
Methods .....	9
II. INTERVIEWS .....	11
Most Common Injuries .....	11
Treatment Options .....	15
III. INTEGRATION OF PUBLISHED MATERIALS AND INTERVIEWS .....	19
Injuries to the Hip .....	19
Anterior and Lateral Snapping Hip Syndrome .....	19
Symptoms and Anatomy.....	19
Diagnostic Testing .....	20
Treatment Options.....	21



Chapter	Page
Acetabular Labrum Tears .....	22
Symptoms and Anatomy.....	22
Diagnostic Testing .....	24
Treatment Options .....	24
Injuries to the Back.....	26
Non-Specific Low Back Pain .....	26
Symptoms and Anatomy.....	26
Diagnostic Testing .....	27
Treatment Options.....	28
Stress Fractures.....	29
Symptoms and Anatomy.....	29
Diagnostic Testing .....	30
Treatment Options.....	31
Conclusion .....	32
 IV. OVERVIEW FOR DANCERS AND TEACHERS .....	 34
Common Dance Injuries .....	34
Anterior and Lateral Snapping Hip Syndrome .....	35
Tearing of the Cartilage in the Hip Socket .....	36
Non-Specific Low Back Pain .....	37
Stress Fractures .....	37

Chapter	Page
Common Treatment Options .....	39
Recommendations.....	41
Preventive Measures .....	43
APPENDICES	
A. MICHELI AND SOLOMON (1997): DIAGNOSIS OF ILIOPSOAS TENDINITIS .....	46
B. SPINA (2007): DIAGNOSIS OF ILIOTIBIAL TENDONITIS.....	47
C. GEORGE AND DELITTO (2002): SUMMARY OF TREATMENT-BASED CLASSIFICATION SYSTEM FOR BACK PAIN .....	48
D. INTERVIEWEE BIOGRAPHIES .....	49
E. EMAIL MESSAGE.....	51
F. INFORMED CONSENT .....	52
G. INTERVIEW QUESTIONS AND TOPICS.....	53
REFERENCES .....	54

## **CHAPTER I**

### **INTRODUCTION**

Injuries are a common occurrence for dancers (Anderson and Hanrahan 2008; Bronner, Ojofeitimi, and Mayers 2006; Hamilton 2005; Lai, Krasnow, and Thomas 2008; Liederbach 2000; Liederbach and Richardson 2007; Micheli and Curtis 2006; Rip, Fortin, and Vallerand 2006; Teitz 2000). “It has been frequently asserted in the literature that dancers are encouraged to accept, tolerate, and persevere through pain and injury, as it is considered to be an inevitable aspect of their dancing career” (Anderson and Hanrahan 2008). With this high tolerance for performing with pain and discomfort and the fear that the diagnosis will call for extended rest and recuperation, dancers will often continue performing even with the knowledge that their injuries should be treated (Anderson and Hanrahan 2008; Clearman 1990; Lai, Krasnow, and Thomas 2008; Solomon, Solomon, and Minton 2005). Nonetheless without proper diagnoses and treatment, injuries linger as the dancer continues activity, causing the problem to reoccur or worsen (Scialom, Gonçalves, and Padovani 2006). Thus, it is critical for dancers to understand common injuries and the treatments available to them. With this knowledge, dancers may be more inclined to promptly seek medical attention when necessary (Anderson and Hanrahan 2008).

When injuries occur, there is a progression of events that follow: dancers often experience symptoms that can lead them to seek medical attention, diagnostic testing is performed by a medical professional, and finally, a treatment regimen specific to the injury is prescribed. The following discussion provides an overview of this progression beginning with some of the possible ways injuries can take place.

With overuse and traumatic injuries being two types of injuries, Marijeanne Liederbach (2000) states, “between 50% and 80% of dancers report overuse syndromes sometime in their professional career. Sixty-five percent of all injuries in dance result from overuse, and the other 35% from trauma.” These kinds of injuries can occur from a range of possibilities including age, sex, general and mental health, body weight regulations, inadequate dancing conditions, poor technique or poor muscle recruitment, choreographic demands or level of performance demands, work-to-rest ratios, or functional abnormalities unique to the individual (Hartog, Smith, and Zujko 2006; Grossman 2010; Humphrey 2010; Liederbach and Richardson 2007; Molnar 2010). Anterior and lateral snapping hip are an example of overuse injuries (Micheli and Solomon 1997; Spina 2007; Teitz 2000); muscle strains are often the result of a traumatic injury; and acetabular labral tears falls into both categories as it can occur as an overuse or traumatic injury (Teitz 2000).

The symptoms associated with these injuries can also range in frequency and intensity. For example, the audible but sometimes painless popping or snapping associated with anterior and lateral snapping hip can seem harmless initially, as dancers can usually continue normal dance activity without interruption. However, over time

this can evolve into a debilitating overuse injury if not closely monitored (Micheli and Solomon 1997; Teitz 2000).

The next step in this progression is diagnostic testing. This is how medical professionals determine what kind of injury the dancer is facing. Doctors and researchers such as Micheli and Solomon (1997), Spina (2007) and Teitz (2000) perform active diagnostic tests that position or move the dancer in specific ways to recreate the pain, discomfort, or find weaknesses (see *Appendices A and B*). In the article, "Management of the Athlete with Low Back Pain," Steven George and Anthony Delitto (2002) partner active diagnostic testing with a categorized charting system to identify the appropriate treatment (see *Appendix C*). Imaging techniques such as electromagnetic radiation (X-rays), magnetic resonance imaging (MRI), computerized axial tomography scans (CT or CAT scans), single photon emission computed tomography (SPECT), or bone scans are often used in conjunction with these tests and with each other to confirm diagnosis (Amari et al. 2009; Grossman 2010; Hartog, Smith, and Zujko 2006; Humphrey 2010; Kocher et al. 2006; Malanga 2009; Micheli and Curtis 2006; Molnar 2010; Rajiah and Karthikeyan 2009). One example is the diagnoses of stress fractures of the lumbar spine where medical professionals utilize a combination of these methods. Signs of instability and weakness are ascertained by asking the dancer to perform different physical tasks. Concurrently, CT scans are often employed to confirm the diagnosis of stress fractures, while MRI scans are also used for their increased sensitivity to soft tissue and joint structure. The combination of these two imaging techniques is useful in providing the best results. Importantly, each method

is a link in the chain of diagnoses assisting the medical professional in narrowing down the specific injury and leading them to the appropriate treatment strategies for recovery (Amari et al. 2009; Humphrey 2010; Malanga 2009; Micheli and Curtis 2006; Molnar 2010; Rajiah and Karthikeyan 2009).

Depending on the severity of injury, the range of treatment methods can vary from conservative to invasive. Examples include PRICE (protection, rest, ice, compression, elevation), NSAIDs (non-steroidal anti-inflammatory drugs), breathing and relaxation techniques, manual therapy, neuromuscular re-patterning, Functional Electronic Stimulation, iontophoresis, trigger point injection, and invasive surgical methods (Fairweather and Sidaway 1993; George and Delitto 2002; Grossman 2010; Hamilton 2005; Hartog, Smith, and Zujko 2006; Humphrey 2010; Kocher et al. 2006; Micheli and Curtis 2006; Micheli and Solomon 1997; Molnar 2010; Sefcovic and Critchfield 2010; Teitz 2000). Similar to diagnostic testing, treatments are also combined in specific ways to achieve the desired outcome. As an example, acetabular labral tears often result in surgical intervention (Hartog, Smith, and Zujko 2006; Kocher et al. 2006; Teitz 2000). Following this treatment, physical therapists might also employ neuromuscular re-patterning, muscle strengthening, range of motion and joint mobility exercises, and manual therapy, among others (Humphrey 2010; Molnar 2010).

## Purpose

The purpose of this project is to: 1) interview physical therapists specializing in dance about injuries of the hip and low back, including diagnostic procedures and treatment options; 2) combine the information from the interviews to expand upon published research on this subject; and 3) create a non-technical, dancer friendly document listing these common injuries and their possible treatments.

## Significance of Study

Many studies have shown that dancers often perform through pain and discomfort without pursuing necessary medical care. Many of these dancers may also be unclear about their injury and the treatment possibilities. The author believes this lack of knowledge along with the mind set that “the show must go on,” is directly related to failures in seeking medical care upon injury. This document aims to be one strategy for helping dancers better understand and articulate their needs as they work with medical professionals to address their injuries in the hip and low back.

## Definition of Terms

The following are definitions that are used throughout this document. All terms were defined as in Stedman’s Medical Dictionary and Merriam-Webster’s Medical

Desk Dictionary, except for the term “manual therapy” which was derived from the interviews with physical therapists, “stress fracture” which is defined as by Micheli and Curtis (2006), and “injury,” which the author is defining for the purposes of this document.

*Amenorrhea:* abnormal absence or suppression of menstruation

*Arthroplasty:* plastic surgery of a joint (as the hip or knee): the operative formation or restoration of a joint; an operation to restore as far as possible the integrity and functional power of a joint

*Arthroscope:* an endoscope that is inserted through an incision near a joint (as the knee) and is used for the visual examination, diagnosis, and treatment of the interior of a joint

*Arthroscopy:* examination of a joint with an arthroscope; also: joint surgery using an arthroscope

*Bursa:* a closed sac or envelope lined with synovial membrane and containing synovial fluid, usually located or formed in areas subject to friction (e.g., over an exposed or prominent part or where a tendon passes over a bone)

*Bursitis:* inflammation of a bursa

*Debridement:* the usually surgical removal of lacerated, devitalized, or contaminated tissue

*Duration:* continuance in time, the time during which something exists or lasts

*Frequency:* the number of recurrences in a given time



*Injury:* an event that disrupts regular dance activity and requires the dancer to seek medical care

*Intensity:* the magnitude of a quantity, as force or energy, per unit (as of area, charge, mass, or time)

*Ligament Sprain:* an injury to a ligament as a result of abnormal or excessive forces applied to a joint, but without dislocation or fracture

*Manual Therapy:* hands-on soft tissue massage, myofascial release, joint mobilization, joint manipulation, trigger points, fascia mobilization, and adjustments

*Muscle Spasm:* a sudden involuntary contraction of the muscles of one or more muscle groups; includes cramps, contractures

*Muscle Strain:* injury resulting from tensile force to muscle or tendon, especially skeletal muscles

*Prone:* having the front or ventral surface downward; especially: lying facedown

*Quadruped:* an animal having four feet; on all fours, on hands and knees

*Spinal Fusion:* surgical fusion of two or more vertebrae for remedial immobilization of the spine

*Spondylolysis:* degeneration or deficient development of a portion of the vertebrae

*Spondylolisthesis:* forward displacement of a lumbar vertebra on the one below it and especially of the fifth lumbar vertebra on the sacrum producing pain by compression of nerve roots

*Stress Fracture:* a skeletal defect that results from repeated applications of stress of lower intensity than that required to fracture a bone in a single loading

*Supine*: lying on the back or with the face upward

*Trigger Point*: a sensitive area of the body which when stimulated gives rise to a reaction elsewhere in the body; especially: a localized usually tender or painful area of the body and especially of a muscle that when stimulated gives rise to pain elsewhere in the body

### Interviewees

There are three physical therapists with excellent first-hand experience in treating dancer injuries that were contacted and interviewed after first gaining human subjects approval: Gayanne Grossman, Amy Humphrey, and Marika Molnar. They have all been or are currently resident physical therapists for major dance companies such as the Pennsylvania Ballet, the Washington Ballet, and the New York City Ballet. They are also members of the International Association of Dance Medicine and Science, and some have published their research in journals such as the *Journal of Dance Medicine and Science* or have published books related to these topics. A list of the interviewees and their biographies are available in *Appendix D*. For the informed consent and email message see *Appendix E* and *F*.

## Methods

This study examined published works in scholarly journals including *Archives of Orthopaedic Trauma Surgery*, *Clinics in Sports Medicine*, *European Spine Journal*, *Journal of the Canadian Chiropractic Association*, *Journal of Dance Medicine and Science*, *Medical Problems of Performing Artists*, and *Research Quarterly for Exercise and Sport*. These works were examined for the most common hip and low back injuries being reported in dancers, what the diagnoses and treatments were for these injuries, and what the outcomes were (e.g., rehabilitation duration and probability of a full recovery).

After locating these publications the location of each injury, the symptoms and how they can occur, the diagnostic testing procedures and treatment options were outlined. Articles covering similar topics were compared to examine the diagnostic procedures and treatments. When possible, varying opinions are presented to provide the reader with an array of recommendations.

The next step was to gain approval from the Office for Protection of Human Subjects. After this was granted, interviewees were contacted and discussions began with the aforementioned physical therapists specializing in dance to uncover their preferences when working with dancer injuries to expand on the published research. (For a list of interview questions see *Appendix G*).

This document aims to provide dancers and dance educators with a clearer understanding of common hip and low back injuries and treatment options with a

further intention to make this information accessible to both dancers and dance educators.

## CHAPTER II

### INTERVIEWS

The author's search for interview subjects began by collecting articles regarding hip and low back injuries in dancers written in various scholarly journals. The authors of these articles were then put into a list of possible interview subjects and from there, individuals were contacted via phone and email. The search returned three physical therapists that were willing and able to share their expertise for this project: Gayanne Grossman, who works with dancers at Muhlenberg College in Pennsylvania; Amy Humphrey, who works with the Washington Ballet; and Marika Molnar, who works with dancers of the New York City Ballet.

#### Most Common Injuries

The interviews began with a set of questions (see *Appendix G*) that were used as a springboard for conversation, such as "What are the most common injuries that you see in the hip and low back?" Grossman (2010) replied with psoas issues, iliotibial band problems, and instability in the sacroiliac joint. Humphrey's (2010) commonly seen injuries revolve mostly around hip impingements, acetabular tearing, spondylolisthesis,

and strains and sprains in the hip and low back. Molnar's (2010) response described issues with hypermobility and instability in the joints along with spondylolysis and spondylolisthesis, and most recently acetabular labral tears.

Most of the issues revealed overuse injuries as the most common type encountered by these physical therapists, however each of them see their fair share of acute injuries. Muscle strains and ligamentous sprains are two examples of acute injuries that a physical therapist might encounter when working with dancers. Humphrey (2010) explains that muscle strain injuries are easier to rehabilitate since it involves the soft tissue and requires a shorter progression as opposed to a stress fracture where the dancer must stop activity and undergo a slow and steady rehabilitation regimen.

Other questions the author asked the interviewees revealed that major risk factors for any of these injuries could be related to choreographic demands; poor technique, which can relate to poor muscle recruitment; weakness in the muscles surrounding the joint, most commonly the core stabilizers; or normal and abnormal occurrences in the body such as growth spurts and amenorrhea.

Regarding choreographic demands, injuries of all sorts develop from the new and unconventional ways choreographers are asking their dancers to move. "The problem is, there is no way to warm up the body to do something like that. The traditional ballet class doesn't really get your body prepared to do that kind of stuff" (Molnar 2010). Molnar continues to talk about the variety of choreographers that are working with professional ballet companies and their ideas for movement. For example,

she explains how some choreographers want the dancers to repeat particular movements such as sitting in the hip. “After a while they’re going to stretch out the gluteus medius on that side and then have an impingement in the groin. Then you have to counterbalance that by doing specific exercises to maintain the integrity of the gluteus medius” (Molnar 2010). Humphrey adds that there are some choreographers that will work with you if you have prior injuries that conflict with their movement. One of her patients with a unilateral hip problem was still able to perform in a work by executing everything on their “good side” (Humphrey 2010). Muscle strains and spasms are common injuries in this type of situation (Humphrey 2010; Molnar 2010).

At the collegiate level, Grossman (2010) often sees dancers in her clinic with instability and muscle recruitment problems that partially stem from poor technique. Injuries in this case could result if they are “a jazz dancer who doesn’t have very good technique and is taking African for the first time... or a beginning ballet dancer and is trying to take an advanced class.” She explains that some dancers “use everything, so they can feel [the movement]” or they recruit the stronger muscles instead of the weaker but appropriate ones in order to execute certain movements, in turn developing bad habits that can later result in injury (Grossman 2010). When patients experience these types of issues she works on breathing and muscle re-patterning that also include imagery cues. For some dancers she even recommends they take a lower level class in their genre to return back to the basics and utilize the simpler exercises as therapy and employ some of their rehabilitation techniques.

Humphrey (2010) and Molnar (2010) both discuss the normal and abnormal bodily functions that can lead to injuries such as stress fractures in the lumbar spine in young women. Humphrey (2010) explains that the demands of body image and other stressful events can lead to eating disorders. With eating disorders, the body cannot receive the nutrients it needs, causing the muscles to take calcium from the bones and causing other normal bodily functions to stop working, such as the menstrual cycle (amenorrhea). This puts the bone in a weakened state, a precursor to stress fractures (Humphrey 2010). Molnar (2010) explains a different precursor to stress fractures, growth spurts. Contrary to eating disorders, growth spurts occur regardless of healthy or unhealthy dancers (of course, the affects between the two may differ). She explains that in young dancers, mostly females, that when their once extremely flexible body encounters a growth spurt, their muscles are stretched the muscles faster than they can adapt to the bone growth. This causes the taut muscles to pull toward the center of the muscle belly, away from the boney attachments. The repeated stress of the dancer attempting to use her body they way it was prior to the growth spurt can then lead to stress fractures. Molnar also notes that the core muscles are often weak during this delicate time and the lumbar spine is particularly vulnerable (Molnar 2010).



## Treatment Options

The next section of remarks from the interviews relates to the treatments utilized by these physical therapists. Two methods that were common between all three interviewees were the use of breathing techniques and neuromuscular re-education.

As a part of working through motor control issues, Grossman (2010), Humphrey (2010) and Molnar (2010) explained some of the methods they employ for rehabilitation and preventative measures with their patients. When prompted about breathing techniques and neuromuscular re-education methods (also referred to as motor control or neuromotor re-patterning and re-education), Humphrey stated, “sometimes we just need to re-teach our bodies how to work” (Humphrey 2010). All three explained how incredibly revealing it is to observe their patients simply walking, along with performing basic movements such as *plié*, *relevé*, *tendu*, and *passé* (Grossman 2010; Humphrey 2010; Molnar 2010). This is when they are able to see some of the most obvious signs of mal-alignment and issues in muscle recruitment. Grossman (2010) stated, “I work on breathing and lumbo-pelvic control right away.” To address these problems they use a series of progressions with breathing and neuromuscular re-patterning to get their patients ready to go back to dancing. “It’s teaching people how to be able to control their different muscles so they can focus on what needs to get done, then we reintegrate it into full usage” (Molnar 2010).

Breathing techniques and re-patterning usually begin by lying on the floor, a level at which muscles can be the most relaxed. Using an example of patients with low

back problems, Molnar explains that she begins by trying to relax the muscles in the lumbar area and teaches them breathing patterns to get their diaphragm moving internally (Molnar 2010). This also gets their diaphragm working fully so the rib cage can expand when inhaling. “As the rib cage expands in that posterior lateral part of the thoracic spine, it helps to lengthen the muscles that attach the ribs to the pelvis. This allows some relaxation to occur in the back. Then you work on very small but good quality contraction of your deep abdominals when exhaling” (Molnar 2010). This also creates an internal and external rhythm with stretching and strengthening the muscles in the trunk (Molnar 2010).

After they successfully complete this task, Molnar works with them in supine with the knees supported. From there they move on to sitting up or side lying and eventually progress to standing. “It may take about a week to get there because it’s a hard thing to do” (Molnar 2010). Afterward, she repeats this progression and adds in seemingly simple movements or positions, such as placing the arms in fifth position to challenge the abdominals. “They’re not going to be able to turn, to jump, or land... until they can stand up,” Grossman says, explaining the importance of progressions from the floor to standing. “Most people can’t stand on two legs in parallel well... If you have a weak posterior gluteus medius, or are tight anteriorly, or can’t coordinate your abdominal muscles with your pelvic floor, you can’t stand well on two legs. If you can’t stand well on two legs, you can’t stand on one. And if you can’t stand in parallel on two legs then you can’t stand in turn out because it’s harder” (Grossman 2010).

Similar to the progression that Molnar described, dissociation activities are another form of neuromuscular re-patterning. With a dissociation activity, the physical therapist blends together the breathing and movement exercises to isolate certain muscles. This helps the body learn which muscles it should be using to carry out certain tasks. In another example for patients with low back problems, Humphrey (2010) states:

*I always start with teaching the client neutral spine position and how to activate their transverse abdominis muscle. This exercise is usually initially taught in supine in hook-lying position and eventually I place the client in other positions (prone, standing, seated, quadruped) and have them do the same thing. Once my patient can demonstrate this neutral position effectively, I begin to have them move their lower or upper extremities or both, while they maintain a neutral position... Next I will ask them to keep [the transverse abdominis activated] while moving their spine (in any direction: forward bend, side bend, rotation). This is where dancers need to get to because they live in extreme ranges of motion not in spine neutral.*

Overall, these three physical therapists share the same ideas when rehabilitating a dancer back to health. Neuromuscular re-education and breathing techniques are large parts of their rehabilitation regimens. Progressions from the floor to standing to dance movements as well as dissociation activities also play major roles in rehabilitation.

The dancer and their choreographer can address problems such as choreographic demands. If an injury is resulting from specific movement or a prior injury is keeping the dancer from doing the movement, this should be discussed with the choreographer. They may be able to allow for modifications within the work or clarify how to execute the movement without creating pain or discomfort. Problems with poor technique are difficult to catch ahead of time if the instructor doesn't have a good eye for these issues. Physical therapists are usually sought after injuries arise, making technique

modifications and re-patterning necessary to get the dancer back to activities and to continue dancing in a safe and effective manner.

These physical therapists are clear that if one does not employ the neuromuscular re-patterning and technique modifications, injuries can resurface. Time is also a consideration on both the physical therapist and dancers' parts. A rushed comeback from an injury can also result in reoccurrence and possibly a short-lived dance career. Although every individual and every injury is unique, dancers can utilize these methods to work toward a positive outcome.

## **CHAPTER III**

### **INTEGRATION OF PUBLISHED MATERIALS AND INTERVIEWS**

The following is a combination of research from the review of literature and interviews with physical therapists Gayanne Grossman, Amy Humphrey, and Marika Molnar that outlines common dance injuries in the hip and low back. Each section will include the symptoms and location of the injury followed by the diagnostic procedures and treatment options.

#### Injuries to the Hip

The injuries that will be discussed in this section include: anterior and lateral snapping hip syndrome (iliopsoas and iliotibial tendonitis, including bursitis) and acetabular labrum tears.

#### **Anterior and Lateral Snapping Hip Syndrome**

##### Symptoms and Anatomy

A common symptom associated with snapping hip is the sometimes painless snapping, clunking, or popping sound audible when the dancer lands from a jump or

returns to neutral after battement à la seconde (Micheli and Solomon 1997; Spina 2007; Teitz 2000). Instructors and coaches often incorrectly dismiss this symptom, as it seems to not cause pain or discomfort. As painless as the initial symptoms might seem, attention should be drawn to this problem (Teitz 2000).

Snapping hip can occur in two ways, anteriorly or laterally. Anteriorly, snapping hip occurs when the iliopsoas tendon snaps over the femoral head or the iliopectineal eminence, presenting symptoms on the gesture leg. This can also occur due to an imbalance between the rectus femoris and iliopsoas muscles. Laterally, snapping hip can emerge when the iliotibial band snaps across the greater trochanter. Symptoms often present directly on the greater trochanter (Teitz 2000). Iliotibial tendonitis can lead to a different kind of problem called greater trochanteric bursitis. With the snapping of the iliotibial band across the greater trochanter, the bursa can become inflamed. Bursitis in this area generally presents behind the greater trochanter and often makes it painful to lie on the symptomatic side (Teitz 2000).

### Diagnostic Testing

Micheli and Solomon (1997) present three diagnostic tests for anterior snapping hip (see *Appendix A*). In the provocative hyperflexion test the patient lays on their back while the examiner slowly flexes the hip. The second diagnostic test requires the patient to assume the frog position while lying on their back and adducting the leg with resistance from the examiner. The third diagnostic test requires the patient to lay with the symptomatic leg hanging off the edge of the table in hyperextension and abduction

while the examiner slowly rotates the leg internally. Teitz offers a fourth diagnosis that utilizes a sit-up with extended knees. During the sit-up action, the examiner holds the feet of the patient for resistance (Teitz 2000). Pain during these diagnostic tests indicates a positive result for snapping hip. Andreo Spina uses similar methods to test for lateral snapping hip. He begins by having the dancer lay on the unaffected side while he moves their leg from hyperextension in the hip and flexion in the knee to a flexed hip. He then palpates for any popping or clicking (see *Appendix B*) (Spina 2007).

#### Treatment Options

Regarding snapping hip and self-treatment, Dr. Peter Marshall recommends rest, avoiding turnout, and staying away from anti-inflammatory medication that could “mask” the pain (Hamilton 2005). Andreo Spina (2007) suggests Active Release Techniques® (ART) for iliotibial snapping. ART is a “soft tissue treatment method that focuses on relieving tissue tension via the removal of fibrosis/adhesion that develops in tissue that is overloaded with repetitive use.” Teitz suggests that dancers be referred to a physical therapist that works consistently with dancers to develop a muscle re-patterning and stretching regimen while continuing conservative measures, such as PRICE and NSAIDs. Ultimately, it is recommended that when returning to activity, as with all injuries, the dancer “include[s] changes in technique in order to maximize the chances for full recovery and minimize the risk for the recurrence of injury” (Teitz 2000).

Physical therapists Gayanne Grossman (2010) and Marika Molnar (2010) also utilize motor control re-education as well as breathing techniques as a treatment regimen standard with their patients. Molnar states, the “most important thing is to make sure that the pelvis is not in an anteriorly rotated position” (Molnar 2010). She teaches exercises that engage the deep abdominals, pelvic floor and the multifidus. She also works with the dancer on to find a neutral pelvic position (in the horizontal plane the anterior superior iliac spine (ASIS) level with the posterior superior iliac spine (PSIS), and ASIS and pubic bone level in the frontal plane) (Molnar 2010).

Micheli and Solomon (1997) have found success with corticosteroid injections (steroids that keep inflammation agents from the problem site) in conjunction with fluoroscopy as treatment for iliopsoas snapping. However, Teitz (2000) reports that it is unnecessary to resort to surgical methods with iliopsoas snapping if conservative measures are fully utilized. Surgical methods for iliotibial snapping are recommended only as a last resort (Teitz 2000).

### **Acetabular Labrum Tears**

#### Symptoms and Anatomy

A review of early research from the mid-20<sup>th</sup> century by Micheli and Solomon (1997) reveal that snapping hip was once referred to as a tearing of the labrum. It wasn't until later (around mid to late 1980s) that a distinction was made between symptoms of an acetabulum labral tear and the snapping of the iliopsoas over the neck of the femur (Micheli and Solomon 1997). Acetabular labral tears, or simply labral tears, can present



with a “sharp catching” sensation or a clicking or locking similar to that of snapping hip syndrome both anteriorly and laterally (Hartog, Smith, and Zujko 2006; Whipple, Plafcan, and Sebastianelli 2004). Hamilton (2005) states that the most common symptom of pain is in the groin, while other research suggests that pain can also occur in the trochanteric or gluteal areas due to its anterior and lateral presence (Teitz 2000; Whipple, Plafcan, and Sebastianelli 2004). The symptomatic pain is usually dull and diffuse and decreases with rest (Hartog, Smith, and Zujko 2006).

Whipple, Plafcan, and Sebastianelli (2004) state that hip instability is often associated with labral tearing. This type of hip injury, which was once also diagnosed as tendonitis in the hip (Hamilton 2005), can present in different ways and can lead to several different issues. Molnar states that labral tearing is “usually from stressing the external rotation and extension of the hip joint” and that it “all depends on the shape of the acetabulum and where the [femoral] head is sitting” (Molnar 2010). Stressing external rotation can cause the head of the femur to sit too far forward in the acetabulum, creating a constant “butting up against the labrum until it gives way” (Molnar 2010). Dancers may have difficulty with movements such as arabesque or any extension over 90° and experience stiffness in the affected hip (Humphrey 2010).

The tearing of the labrum can occur in a variety of ways but occurs often with minor trauma such as “twisting or rotating” on the weight bearing leg (Whipple, Plafcan, and Sebastianelli 2004). Hartog, Smith, and Zujko (2006) define four different etiologies of a labral tear: *traumatic tearing*, which presents itself with a specific situation in which the tear occurred; *degenerative tearing*, showing symptoms of

degeneration in the labral or articular cartilage; *idiopathic tearing*, tearing that occurs without a clear cause of its incidence; and *congenital tearing*, which is generally caused by a functional abnormality (Hartog, Smith, and Zujko 2006).

### Diagnostic Testing

The diagnostic tools are similar to those previous described by Micheli and Solomon (1997), and Teitz (2000) for snapping hip. Hartog, Smith, and Zujko (2006) also add the Thomas test (laying supine in passive hip flexion into hip extension) to the list although they report its results are inconsistent. However, many diagnosticians have found variations of the Thomas test to provide true positive results.

Imaging tests provide another venue for the diagnosis of a labral tear, however there are conflicting opinions regarding its reliability. Kocher and associates (2006) indicate that imaging techniques are less effective in detecting labral tears, however others think that MRIs are useful in confirming diagnosis (Humphrey 2010; Teitz 2000). In Hartog, Smith, and Zujko's (2006) review article, studies suggest that a MRI alone can create false negatives, but that a MRI arthrography with gadolinium contrast can decrease these false negatives. Teitz also adds that finding a labral tear on a MRI requires high-level skill on the part of the radiologist (Teitz 2000).

### Treatment Options

Hartog, Smith, and Zujko (2006) state that there is a lack of recorded success with conservative treatments for acetabular labral tears. NSAIDs, in combination with

physical therapy, activity modification, aquatic training, and rest are useful treatment options (Hartog, Smith, and Zujko 2006). Molnar states, “If it’s an anterior-superior tear, that usually means the head of the femur is slightly up and forward. You need to mobilize that hip joint and get the head of the femur posteriorly into the hip socket better” (Molnar 2010). She gives an example of allowing the head of the femur to glide into the posterior aspect of the acetabulum by going into a hands and knees, or quadruped position. She also stresses the importance of stretching muscles in opposing directions instead of only one, i.e. – turned out and turned in (Molnar 2010).

Kocher and associates (2006) have determined that “Once a tear is detected, the dancer has two basic options: ...find ways of “working around” the injury (practitioners of manual medicine may provide some assistance with this), or undergo surgical treatment, most commonly, an arthroscopic labral debridement.” An arthroscopic labral debridement requires general anesthesia and “small capsular releasing incisions with an arthroscopic knife” (Kocher et al. 2006).

Post-surgery, physical therapists utilize strengthening around the hip, gluteals, hip rotators, adductors, abductors, and the core. Neuromotor re-education, range of motion and joint mobilization exercises are also employed (Humphrey 2010). Physical therapists will usually take their patient through a progression. Humphrey begins with the basics, working with simple floor and barre exercises. After these are skillfully accomplished the patient then moves toward center floor activities and eventually progresses to turns and jumps (Humphrey 2010).

## Injuries to the Back

Two back problems are discussed here: non-specific low back pain, including hypermobility, strains and sprains; and stress fractures including spondylolysis and spondylolisthesis.

### **Non-Specific Low Back Pain**

#### Symptoms and Anatomy

George and Delitto (2002) suggest that low back pain is often from a benign source; however patients can experience low back pain from a specific source such as a pressed nerve or stress fracture. In Linda Hamilton's article "Five Common Injuries and How to Treat Them," New York chiropractor, Dr. Lawrence DeMann Jr. says when treating a dancer with low back pain it is common for him to hear the words, "My back is out" (Hamilton 2005). This is called joint fixation. According to Hamilton and her collection of advice from other medical professionals, joint fixation is a common occurrence where "the back freezes up, causing a localized aching pain over a specific joint that limits movement (rather than a nerve pain that radiates down an arm or leg from a ruptured or degenerative disc)" (Hamilton 2005).

Muscle strains in the low back are also a cause of non-specific low back pain, which in turn can cause a muscle spasm. This occurs when the muscles surrounding the irritation or injury protect the area by staying in constant contraction (Humphrey 2010; Molnar 2010). In interviews with Humphrey (2010) and Molnar (2010), they both use

examples of dancers pushing too hard when performing movements such as layouts or lifting other dancers. Molnar (2010) describes an event that can occur with either males or females involving the quadratus lumborum muscle that attaches the ribs to the pelvis. A dancer is lifting another dancer while in intense rotation. This could cause the quadratus to be under extreme stress. From here the quadratus could go into a spasm and pull down on the attached rib. “The rib gets stuck in that position because all of the other muscles go into spasm as well” (Molnar 2010). This can also cause pain down to his gluteal area and an inability to un-rotate (Molnar 2010). Emotional stress can increase these symptoms (Hamilton 2005).

Hypermobility is another low back problem. Humphrey suggests this could be a precursor to stress fractures or vertebral slipping, which is discussed in the next section. This presents with a forward chest, increasing the lumbar’s lordosis and over stretching the abdominals, which in turn creates a muscle imbalance (Humphrey 2010).

### Diagnostic Testing

Linda Hamilton’s article suggests, when diagnosing problems in the low back, that if it seems difficult to determine a reason for low back pain, the occurrence could be the product of “fatigue, hypermobility, scoliosis, leg length inequalities, and emotional stress” (Hamilton 2005). George and Delitto (2002) gauge the severity of the injury with a variety of questionnaires. Any positive responses to the questionnaires are reviewed with the patient. Resistance and strength tests are usually combined with questionnaire responses to assist with acquiring the appropriate treatments. Imaging

tools, such as CAT scans or MRIs are often utilized to rule out any skeletal issues like stress fractures (George and Delitto 2002).

### Treatment Options

Treatments for low back pain include but are not limited to heat and cold compression, breathing techniques, massage, deep abdominal or trunk-strengthening exercises, traction, mobilization and immobilization (George and Delitto 2002; Hamilton 2005; Humphrey 2010; Molnar 2010). Molnar recommends physical therapy for a reduction in swelling, and “using heat and cold, which speeds up the exchange of fluids and brings a fresh blood supply to the area” (Hamilton 2005). She also suggests specifically that sit-ups are avoided during the acute phase because this action compresses the disks of the lumbar spine (Hamilton 2005; Molnar 2010). After the acute phase, she suggests stabilization methods such as deep abdominal exercises for the back and pelvic girdle.

Humphrey (2010) states that soft tissue injuries such as low back pain including sprains and strains are easier to rehabilitate than skeletal injuries. It can take about 4-6 weeks to heal depending on the severity, with an initial 7-10 days of rest in conjunction with conservative treatment methods including alternating heat and ice. She also recommends taking the first 24-72 hours off from activity. After the pain is manageable and the dancer can return to activity, again depending on the severity, they can modify class as to not irritate the injury. Movements such as jumping, and lumbar

hyperextension (cambré and arabesque) are not recommended upon initial return to dance activity (Humphrey 2010).

## **Stress Fractures**

### **Symptoms and Anatomy**

Micheli and Curtis (2006) present research on stress fractures in the spine and sacrum and define a stress fracture as “a skeletal defect that results from repeated applications of stress of lower intensity than that required to fracture a bone in a single loading” (Micheli and Curtis 2006). The most common stress fractures are in the lumbar (spondylolysis) and sacrum. Common causes for stress fractures include repetitive stress, progressive exhaustion, compression forces, high demand on hyperextension, and increased axial load and rotation (Micheli and Curtis 2006).

Spondylolisthesis can occur as a result of spondylolysis. In spondylolisthesis, the vertebral body actually slides forward. This most commonly occurs in L5-S1, where L-5 slides forward from S-1. The severity of slippage is measured on a graded scale of 1-4, 4 being the most severe. The symptoms of spondylolysis and spondylolisthesis include: low back pain, particularly in hyperextension or standing on one leg such as in arabesque; tenderness directly on spine (as opposed to muscles on sides of spine); radiating pain down legs; and tightness in one hamstring. Occasionally these types of injury can present without any pain (Clippinger 2007).

When asked about spondylolysis, Molnar states, “that’s a very common ballet injury” (Molnar 2010). She explains that it is most common in females in their late

teens and early twenties. Stress fractures often present in young females who are very flexible and then hit a growth spurt. Unable to immediately adjust to such a quick growth, the muscles become taut and pull on the bones as the dancer continues to move as she did prior to the spurt. “The abdominal musculature is very weak at this time... and there is vulnerability in the pedicle” (Molnar 2010). Humphrey adds that eating disorders, training disorders, and amenorrhea, causing an osteoporotic issue, all add to the chances of developing a stress fracture (Humphrey 2010).

#### Diagnostic Testing

The range of diagnostic testing is far less vast for stress fractures. Humphrey offers some observational instability tests like if the patient bends over and has to use their arms to get back up, or observing a “step-off” or forward shift in the spine when the patient is prone. An active test on both the patient and the physical therapist’s part is to have the patient lie with the lower half hanging off of a table, then extend their legs off of the floor, similar to playing “airplane,” at the same time the physical therapist places pressure on the spine. “If you decrease the pain, that’s a sign that the level is stable because of the pressure you administered” (Humphrey 2010).

Research shows that CT scans are very valuable tools in confirming diagnosis. “MRI is the only modality that is more sensitive than CT, owing to its ability to depict soft tissue and joint structures” (Rajiah and Karthikeyan 2009). When combined with MRI scans, either before or after the use of a CT and single photon emission computed tomography, or SPECT imaging, results are often more accurate in confirming the



diagnosis of a stress fracture (Amari et al. 2009; Humphrey 2010; Malanga 2009; Micheli and Curtis 2006; Molnar 2010).

### Treatment Options

Treatment options include immobilizing braces, rest, breathing techniques, muscle re-patterning, core stabilization activities, and non-weight bearing activities lasting anywhere from four to twelve weeks (Micheli and Curtis 2006). Depending on the severity, Molnar works to relax the muscles around the lumbar spine and teaches her patients a “good breathing pattern” to get the diaphragm moving (Molnar 2010). “As the rib cage expands in that posterior lateral part of the thoracic spine, it helps to lengthen the muscles that attach the ribs to the pelvis. This allows some relaxation to occur in the back. Then you work on very small but good quality contraction of your deep abdominals when exhaling” (Molnar 2010). This also creates an internal and external rhythm with stretching and strengthening the muscles in the trunk (Molnar 2010).

After they successfully complete this task, Molnar works with them in supine with the knees supported. From there they move onto sitting up or side lying and eventually progress to standing. “It may take about a week to get there because it’s a hard thing to do” (Molnar 2010). Similar to the progression that Molnar described, dissociation activities are often employed as another form of neuromuscular re-patterning. With a dissociation activity, the physical therapist blends together the

breathing and movement exercises to isolate certain muscles. This helps the body learn which muscles it should be using to carry out certain tasks. Humphrey (2010) states:

*I always start with teaching the client neutral spine position and how to activate their transverse abdominis muscle. This exercise is usually initially taught in supine in hook-lying position and eventually I place the client in other positions (prone, standing, seated, quadruped) and have them do the same thing. Once my patient can demonstrate this neutral position effectively, I begin to have them move their lower or upper extremities or both, while they maintain a neutral position... Next I will ask them to keep [the transverse abdominis activated] while moving their spine (in any direction: forward bend, side bend, rotation).*

Humphrey (2010) stresses the importance of the progression and states that, “dancers don’t live in neutral spine.” Thus making it imperative to include exercises that move through neutral, standing and other basic movements (Humphrey 2010).

## Conclusion

Based on the information provided in this section, it is reasonable to suggest that many of these types of injuries can be rehabilitated with closely monitored neuromuscular re-education and breathing techniques along with manual therapy. At times, surgical intervention is a necessary step in recovery for dancers with injuries that cannot be managed or healed by conservative measures alone. Post- surgery physical therapy is highly recommended in order to get back to dance activities.

Technique modification and the application of motor control re-patterning must be utilized when returning to dance activities in order to keep the reoccurrence of injuries at bay. It may be necessary to continue taking classes at various levels, i.e. –

both beginning and advanced, in order to move at a slower pace and utilize therapeutic practices such as motor control re-patterning. Studies have also shown that a relative balance of rest and activity are crucial for the mind and body's ability to retain the information received from neuromuscular re-education. On the other side, studies have also revealed that an unbalanced combination of rest and practice can further contribute to overuse syndromes (Batson 2007).

Finally, it is concluded that recovery from any injury requires time and patience. A dancer should be made aware of a reasonable timeline in which they can return to full dance activities. Rushing treatments or loosely adhering to therapy recommendations can cause injuries to reoccur or in some cases, worsen to the point of a shortened dance career. It is recommended that dancers with any injuries (pain or discomfort that keeps dancers away from or makes it difficult to participate in activity) seek medical assistance from a doctor or physical therapist that specializes in dance.

## **CHAPTER IV**

### **OVERVIEW FOR DANCERS AND TEACHERS**

The following is a combination of research from the review of literature and interviews with physical therapists Gayanne Grossman, Amy Humphrey, and Marika Molnar. This chapter focuses on presenting information for the layperson without dance science training, yet provides the necessary information to educate the reader about these injuries. An overview of the common injuries in the hip and low back will be discussed followed by possible treatment options. Next, recommendations regarding neuromuscular rehabilitation will be offered. The concluding section will present changes in training and warning signs to watch out for as preventative measures in dance activities.

#### Common Dance Injuries

The injuries that will be discussed in this section include: anterior and lateral snapping hip syndrome (iliopsoas and iliotibial tendonitis, including bursitis), the tearing of cartilage in the hip socket (acetabular labrum tears), non-specific low back pain (including strains, sprains, and hypermobility issues), and stress fractures of the low back (spondylolysis, including spondylolisthesis).

### **Anterior and Lateral Snapping Hip Syndrome**

With snapping hip syndrome it is common to hear a snapping, clunking, or popping sound when landing from a jump or returning to neutral after *battement à la seconde*. While this sound is audible, it can present without any pain or discomfort (Micheli and Solomon 1997; Spina 2007; Teitz 2000). As painless as the initial symptoms might seem however, attention should be drawn to this problem immediately (Spina 2007; Teitz 2000).

Snapping hip can occur in two ways, 1) in the front of the hip (anterior, or also called iliopsoas tendonitis) or, 2) on the side (lateral, or also called iliotibial tendonitis). Dancers will experience the symptoms of anterior snapping hip in the gesture leg as opposed to the standing leg. This happens when a hip flexor muscle, called the iliopsoas, snaps over bony knobs in the pelvis (such as the iliopectineal eminence or the head of the femur). A muscle imbalance between the quadriceps (rectus femoris) and the iliopsoas can cause this snapping (Teitz 2000).

The symptoms of lateral snapping hip will be experienced on the greater trochanter of the standing leg (a bony landmark on the side of the hip). This happens when the long fibrous band called the iliotibial band snaps across this bony landmark (Spina 2007; Teitz 2000). Constant lateral snapping hip, or iliotibial tendonitis, can eventually cause another problem called greater trochanteric bursitis. Underneath the

iliotibial band there is a small fluid-filled sac called a bursa. Bursas are in many places in our bodies and help muscles or tendons slide over bony projections with ease. With a constant snapping of the IT across the greater trochanter, this bursa can become inflamed and painful. Bursitis in this area generally presents behind the greater trochanter (posterior) and often makes it painful to lie on that side (Teitz 2000).

### **Tearing of the Cartilage in the Hip Socket**

Inside of the hip socket (acetabulum) where the femur sits inside like a ball in a socket, there is a protective blanket (cartilage) that prevents the bones from rubbing together and enhances the acetabulum rim to increase the depth of the socket. When torn, a dancer might feel a “sharp catching” sensation or a clicking or locking similar to that of the snapping hip syndrome previously discussed (Hartog, Smith, and Zujko 2006; Whipple, Plafcan, and Sebastianelli 2004). This is called an acetabular labral tear. The most common symptoms are pain in the groin, on the trochanter, or in the gluteal area of the affected side (Hamilton 2005; Teitz 2000; Whipple, Plafcan, and Sebastianelli 2004). This is usually dull and diffuse and decreases with rest (Hartog, Smith, and Zujko 2006).

The tearing of the labrum can occur in a variety of ways but occurs often with minor trauma such as “twisting or rotating” on the weight bearing leg (Whipple, Plafcan, and Sebastianelli 2004). Labral tearing can also be caused from excessive external rotation and extension at the hip. Its presence can also be related to the shape of the acetabulum and where the head of the femur is sitting (Molnar 2010). Stressing

external rotation can cause the head of the femur to sit too far forward in the acetabulum, creating a constant friction against the labrum (Molnar 2010). Dancers may have difficulty with movements such as arabesque or any extension over 90° and experience stiffness in the affected hip (Humphrey 2010). Other issues can present as a result of an acetabular labral tear, such as an inflamed iliopsoas from over working the affected hip (Humphrey 2010).

### **Non-Specific Low Back Pain**

Muscle strains or ligament sprains occur when an area is being over worked (e.g., pushing too hard in layouts, lifting other dancers without correct alignment or muscle usage). Muscle strains can also lead to another problem called a muscle spasm. This occurs when the muscle group surrounding the strained muscle protects the area by staying in constant contraction (Humphrey 2010; Molnar 2010). Hypermobility joints are less stable than normal joints. This increases the risk of injuries such as muscle strains and ligament sprains (McCormack 2010).

### **Stress Fractures**

A stress fracture in the low back (lumbar) is also called spondylolysis. This happens when there is a constant overloading on the area, creating a weakness in the bone. It is suggested that hypermobility could be a precursor to stress fractures of the low back. This presents with a forward chest, increasing the low back curve (hyperextension or sway back) and over stretching the abdominals, which in turn

creates a muscle imbalance (Humphrey 2010). Other causes for stress fractures include compression forces, high demand on hyperextension, and increased rotation (Micheli and Curtis 2006).

Stress fractures can also occur as a result of growth spurts, typically in young females. This usually happens when the bones grow at a faster rate than the muscles can adjust, creating a tension at the muscle attachment pulling on the bone (Molnar 2010). Eating disorders are another contributor to stress fractures, as the bones grow weaker without proper nutrition (Humphrey 2010).

Spondylolisthesis is another low back injury that can occur, although not exclusively, as a result of stress fractures. This is when a vertebra (a segment of the spine) actually slides forward toward the abdomen. Movements including hyperextension coupled with rotation and loading (e.g., lifting another dancer) can lead to this type of injury (Micheli and Curtis 2006). The symptoms of spondylolysis and spondylolisthesis include: low back pain (particularly when in hyperextension or standing on one leg such as in arabesque); tenderness directly on the spine (as opposed to muscles on the sides of spine); radiating pain down legs; and tightness in one hamstring. Occasionally these types of injuries can present without any pain (Clippinger 2007).



## Common Treatment Options

Typically there is more than one treatment option for injuries. PRICED (Protection, Rest, Ice, Compression, Elevation, and Diagnosis), which was built from the acronym “RICE,” is the most readily available self-treatment option for acute injuries (Sefcovic and Critchfield 2010). PRICED suggests the dancer discontinue activity to prevent further damage (Protection). The dancer should then rest the injured area by taking time off from activity (Rest). To keep the swelling to a minimum, ice should be applied to the injured area for 20-30 minutes every two hours (Ice). Similar to “Protection,” compression should be appropriately applied to the injured area by wrapping an elastic bandage around the injury. It is important to not wrap the injury too tightly and cut off the flowing blood supply (Compression). When at rest, the dancer should keep the injury elevated above the heart to keep the blood supply from pooling in the area and causing more pain and swelling (Elevation). For the final step in PRICED, all acute injuries should be examined by a medical professional for proper diagnosis. From there, the medical professional can further prescribe a treatment regimen appropriate for the injury (Sefcovic and Critchfield 2010).

PRICED, along with many other treatment options, is considered a conservative treatment method (Sefcovic and Critchfield 2010). Other conservative treatments that do not require injection into the body or surgical intervention include: neuromuscular re-patterning, technique modification, strengthening and stretching exercises, manual therapy (including massage, adjustments, trigger point therapy, traction, joint

mobilization and manipulation), and breathing and relaxation techniques (Fairweather and Sidaway 1993; George and Delitto 2002; Grossman 2010; Hamilton 2005; Hartog, Smith, and Zujko 2006; Humphrey 2010; Kocher et al. 2006; Micheli and Curtis 2006; Micheli and Solomon 1997; Molnar 2010; Teitz 2000). Conservative treatments like these can be used to treat many injuries such as anterior and lateral snapping hip and muscle strains (Humphrey 2010; Teitz 2000).

Conservative treatments are also used as post-therapies for injures such as acetabular labral tears, which may require surgical intervention (Humphrey 2010). Other treatments like corticosteroid injections (a steroid that keeps the swelling down) are used for more severe cases of anterior snapping hip, where swelling is occurring due to the constant friction of the iliopsoas over a bony projection in the pelvis (Micheli and Solomon 1997).

Surgical intervention is the most invasive of treatment options. In the case of a labral tear, two incisions are made near the injured site. One incision is for a camera (arthroscope) while the other is made for a small instrument that will clip the torn cartilage. Occasionally a boney abnormality can be the cause of an acetabular labral tear, which may then require a joint resurfacing in which an arthroscope is used to guide a hook-like tool that shaves down the projection to a smooth surface. In some cases, a complete replacement of the hip is necessary. This is called arthroplasty (Humphrey 2010).

## Recommendations

When asking physical therapists Grossman (2010), Humphrey (2010) and Molnar (2010), about common injuries and treatments of the hip and low back, one major idea became the through line between each of their interviews, neuromuscular re-education. The idea to use neuromuscular re-education, or muscle re-patterning, as rehabilitation is not a new concept in the world of physical therapy for dancers, however it is yet another form of conservative treatment that dancers can practice on their own and utilize in their self-treatment regimen.

With the initial guidance of a physical therapist, or other knowledgeable and qualified individual, muscle re-patterning takes the dancer to back to the bare essentials of movement, training their body to recalculate movement patterns in a safe and efficient manner. This helps the body learn which muscles it should be using to carry out certain tasks. Along with the retraining of neuromuscular patterning, the dancer might also go through a series of dissociation activities. “It’s teaching people how to be able to control their different muscles so they can focus on what needs to get done, then we reintegrate it into the full usage” (Molnar 2010). With a dissociation activity, the physical therapist blends together breathing and movement exercises to isolate certain muscles. It teaches the dancer how to recruit the most appropriate muscles for certain movements as opposed to the more convenient ones that they may have utilized previously (Grossman 2010; Humphrey 2010; Molnar 2010). Grossman explains that some dancers “use everything, so they can feel [the movement]” or they recruit the

stronger muscles instead of the weaker but more appropriate ones in order to execute certain movements, in turn developing bad habits that can later result in injury (Grossman 2010).

The progression of rehabilitation through neuromuscular re-education and dissociation activities starts by taking the dancers through simple tasks (e.g., laying down and learning a breathing pattern that targets certain muscle groups in the core). Gradually the series of breathing and movement becomes more complex until they can perform these movements in various positions (e.g., laying down, laying on their side, on all fours, standing, etc.). These ideas then translate into the dancer's movement vocabulary (e.g., turning, jumping, etc.) Eventually the dancer can then add these concepts into their practice to retrain their muscle memory and recruit the proper muscles to complete the task at hand in the most safe and efficient way while in class or when utilizing these ideas during self-training sessions.

As a final note, these physical therapist' encourage the use of basic movements first to re-train the body's muscle memory, then gradually build to incorporating these concepts into their more complex movement vocabulary. This is because dancers do not live in a neutral position, but in extreme ranges. After they learn to dissociate the incorrect usage and reintegrate the appropriate usage, they can then re-associate these ideas into their regular movement vocabulary. It is with these methods of rehabilitation, that physical therapists can work with the dancer back to health.

## Preventive Measures

While conservative treatments, including those described above, are available to dancers to utilize in their self-treatment regimen to rehabilitate injury, some of these ideas are also useful as preventative measures.

First, it is important for dancers to understand that there are two types of practice related to time. Motor skill acquisition is best accomplished by “distributed practice” where time spent in rest is equal to or greater than that of active practice. “Mass practice” is when the time spent doing active work is far greater than the amount of rest between sessions (Batson 2007). It has been shown that dancers with a relative balance of rest and practice can retain the neuromuscular re-education training better than those who do not during a single training session. In fact, literature has suggested that an imbalance of rest and dance activity can contribute to overuse syndromes (Batson 2007).

As the beginning of an academic semester closes in, when productions are up and running, or when tours begin, changes in the dancers’ schedule may be inevitable. Studies show that injuries are most frequent when returning from periods of non-activity (i.e., vacation) (Solomon 1999). Dancers should look out for changes in the frequency, duration, and/or intensity of their activity level. Frequency refers to how often the dancer participates in activity. Duration refers to the amount of time spent in activity. Intensity is the percentage of maximum demand of energy, similar to a change in routine such as taking a new class with an instructor who pushes for maximum

energy, lots of jumps, quick movement, etc. or performing in a new work with demands that are different from the accustomed levels of activity. Changes in any of these areas can increase the risk of injury without the progressive physiological development training required to meet the new higher demands.

For example, on a regular schedule a college student may take class twice daily with a two-hour rehearsal in the evening. During concert week their class schedule remain the same while adding multiple performances. Dancers in a company may shift from taking class in the morning with rehearsals throughout the day to being on the road and having to perform twice a day without their regular class time and rest. These changes in frequency, duration, and intensity can heighten the chance for injury, which make it imperative for dancers to recognize in order to prevent injury.

Another movement option is for the dancer to engage in classes that move at a slower pace and works on basic concepts of movement, such as a beginning level class. By training a lower level the dancer can take more time and apply their self-treatment regimen in order to return from injury or prevent the onset of injury. This may mean the dancer takes their advanced level at the same time as the beginning level, or takes time off from the advanced level to re-work the body's movement patterns.

Nonetheless, if a dancer feels that something is wrong in their body, or finds they are experiencing pain and discomfort with movement, they should seek care from a medical professional, rather than putting up with the pain and later having to take an extended amount of time away from dance activity. They should also not try to diagnose and treat injuries or problems alone. Medical professionals, preferably ones

that work with dancers or athletes, can help to prevent injury or diagnose and treat injuries when they occur.

## APPENDIX A

## MICHELI AND SOLOMON (1997): DIAGNOSIS OF ILIOPSOAS TENDINITIS



**Figure 6.2** Provocative hyperflexion test. The hip is slowly, progressively, and passively flexed by the examiner. (Reprinted from Micheli and Solomon, 1997)



**Figure 6.3** Leg-pull test. The patient flexes and pulls in the leg, trying against the examiner's resistance. (Reprinted from Micheli and Solomon, 1997)



**Figure 6.4** With the leg bumping over the table, the hip is slowly, progressively rotated internally. (Reprinted from Micheli and Solomon, 1997)

Reprinted from Micheli L, Solomon R. Treatment of recalcitrant iliopsoas tendonitis in athletes and dancers with corticosteroid injection under fluoroscopy. *J Dance Med Sci.* 1997;1(1):7-11. With permission of J. Michael Ryan Publishing, Inc.



**APPENDIX B****SPINA (2007): DIAGNOSIS OF ILIOTIBIAL TENDONITIS**

*Figure 1a Starting position for the side lying test for external coxa saltans. Lying with the unaffected side down, the affected hip is passively adducted, then moved from full extension, to 90 degrees of flexion.*



*Figure 1b Ending position. As the ITB complex travels over the greater trochanter, the practitioner palpates for a click/snapping.*

Reprinted with Permission from Publication Journal of Canadian Chiropractic Association, 2007; Vol 51. Andreo Spina, External Coxa Saltans (Snapping Hip) Treated with Active Release Techniques®: A Case Report, 23-29.

## APPENDIX C

### GEORGE AND DELITTO (2002): SUMMARY OF TREATMENT-BASED CLASSIFICATION SYSTEM FOR BACK PAIN

Classification	Key Examination Findings	Recommended Treatment
Extension syndrome	<ul style="list-style-type: none"> <li>• Flexion activities increase pain</li> <li>• Status improves with extension testing</li> <li>• Status worsens with flexion testing</li> </ul>	<ul style="list-style-type: none"> <li>• Extensions exercises</li> <li>• Restriction of flexion activities</li> </ul>
Flexion syndrome	<ul style="list-style-type: none"> <li>• Extension activities increase pain</li> <li>• Status improves with flexion testing</li> <li>• Status worsens with extension testing</li> </ul>	<ul style="list-style-type: none"> <li>• Flexion exercises</li> <li>• Restriction of extension activities</li> </ul>
Mobilization syndrome (lumbar)	<ul style="list-style-type: none"> <li>• Local, unilateral LBP</li> <li>• Patterned, restricted range of motion</li> </ul>	<ul style="list-style-type: none"> <li>• Mobilization techniques</li> <li>• Manipulation techniques</li> </ul>
Mobilization syndrome (sacroiliac)	<ul style="list-style-type: none"> <li>• Local pain at PSIS</li> <li>• Positive sacroiliac tests</li> </ul>	<ul style="list-style-type: none"> <li>• Mobilization techniques</li> <li>• Manipulation techniques</li> </ul>
Immobilization syndrome	<ul style="list-style-type: none"> <li>• Frequent episodes of LBP</li> <li>• Increased pain with static posture</li> </ul>	<ul style="list-style-type: none"> <li>• Avoidance of sustained posture</li> <li>• Trunk strengthening exercises</li> </ul>
Lateral shift syndrome	<ul style="list-style-type: none"> <li>• Visible deformity</li> <li>• Unilateral side bending restriction</li> </ul>	<ul style="list-style-type: none"> <li>• Pelvic translocation exercises</li> <li>• Extension exercises</li> </ul>
Traction syndrome	<ul style="list-style-type: none"> <li>• Radicular symptoms</li> <li>• Status worsens with lumbar movements</li> </ul>	<ul style="list-style-type: none"> <li>• Mechanical traction</li> <li>• Autotraction</li> </ul>

Reprinted from Publication Clinics in Sports Medicine, Vol 21, number 1, Steven Z. George and Anthony Delitto, Management of Athlete with Low Back Pain, 105-120, Copyright 2002, with permission from Elsevier.

## APPENDIX D

### INTERVIEWEE BIOGRAPHIES

The three physical therapists that were interviewed are: Gayanne Grossman, Amy Humphrey, and Marika Molnar:

Gayanne Grossman, PT, EdM-

Gayanne Grossman PT, EdM is a physical therapist for dancers at Muhlenberg College and an Associate Instructor of Anatomy and Kinesiology for Temple University and Muhlenberg College dance programs. Gayanne is serving on the Board of Directors and the Education Committee for the International Association for Dance Medicine and Science (IADMS). She holds a BFA in Dance and a BS in Physical Therapy from the University of Utah. She has an EdM in Dance Education from Temple University where she conducted Ph.D. studies. Her professional experience includes: physical therapy services for the University of Utah Departments of Ballet and Modern Dance, the Pennsylvania Ballet, Muhlenberg College Department of Theater and Dance, Temple University Department of Dance, and the Princeton Ballet School.

In addition to kinesiology, her teaching experience includes modern dance technique for the University of Utah Department of Continuing Education, conditioning, and injury prevention classes and workshops for various dance schools and summer programs including the Rock School of the Pennsylvania Ballet and the Princeton Ballet School.

She has conducted original research on conditioning programs, which enhance dance performance and methods to validate turnout measurement. Gayanne has authored several papers and a book chapter on subjects such as physical therapy for dancers, management of dance injuries, advocating for dance science education and dance specific conditioning. She lectures nationally and internationally on dance medicine and science. She served as a Content Expert for the Performing Arts Practice Analysis and as the Chair of the Nominating Committee for the American Physical Therapy Association's (APTA) Performing Arts Special Interest Group.

(Source: <http://www.muhlenberg.edu/depts/theatre/bio/grossman.htm>, accessed 12/07/09)

Amy Humphrey, DPT, OCS, MTC:

Amy received her Doctorate from the University of St. Augustine in 2007 and her Masters in Physical Therapy from Widener University in 2002. Since her arrival at BDI in 2003, Amy has worked with many different orthopaedic conditions and specializes in manual therapy in addition to performing arts physical therapy. Amy has worked with several performing artists at the Kennedy Center, Wolf Trap, The Universal Ballet Academy/Kirov Academy, Washington Ballet, and at Ford's Theater. Amy has also provided physical therapy services and Pilates/fitness services at Skatequest in Reston and the Ashburn Ice House. Prior to her physical therapy degree, Amy received a Bachelors degree in both Dance and Spanish from James Madison University. She received her Manual therapy Certification in 2007.

(Source: <http://www.bodydynamicsinc.com/staffprofiles.html>, accessed 5/10/10)

Marika Molnar, PT-

Marika Molnar, PT, Lac, is the President and Founder of Westside Dance Physical Therapy. Marika is a graduate of Columbia University, where she obtained her graduate certificate in physical therapy. She also holds a masters degree in dance education from New York University, a certificate in nutrition from the Institute for Integrative Nutrition and holds a masters in acupuncture from Tristate College of Acupuncture. In 1980 Ms. Molnar was the first physical therapist to be hired on-site at a professional ballet company to care for the dancers of the New York City Ballet. She is presently the director of physical therapy services to the New York City Ballet and also director of physical therapy services to the School of American Ballet in New York. Ms. Molnar is active professionally in a number of endeavors. These activities include clinical advisor to PhysicalMind Institute, rehabilitation editor of the Journal of Dance Medicine and Science, and member of the Development Committee of the International Association of Dance Medicine and Science (IADMS). Her previous IADMS committee work includes being a board member from 1994-1999, president from 1999-2001 and Chair of the Education committee from 2001-2003. Ms. Molnar has lectured nationally and internationally for the past 28 years and has published in peer-reviewed publications and also book publications related to rehabilitation of dance injuries.

(Source: <http://westsidedancept.com/wordpress/about/staff/>, accessed 12/07/09)

**APPENDIX E**  
**EMAIL MESSAGE**

Dear \_\_\_\_\_:

I am a MFA candidate at the University of Oregon Department of Dance. I am looking to complete my written thesis in partial fulfillment of my degree by creating a document that discusses common dance injuries in the hip and low back. I will be compiling information both from a review of literature and interviewing physical therapists that have experience with dancers. Physical therapists currently working with dancers and have long term experience in the field of dance medicine and science are being included in the pool of interviewees.

I would like to invite you to participate in my research as an authority in dance science by answering questions over a telephone interview. Prior to the interview I will send you an outline of the questions I'd like to cover with you. I will ask you about the kinds of injuries you are seeing in the hip and low back, and about your preferred diagnostic and treatment methods.

Your thoughts and opinions will be compiled with other physical therapists that are currently working with dancers, allowing dancers and researchers to see the many options and up-to-date opinions about injuries to the hip and low back and their treatments.

I expect the interview to take place between January 2010 and March 2010. Specific scheduling of the interview can be matched to your schedule for your convenience.

If you would like to participate in this study you may respond directly to this email. You may also reach me on my cellular phone at (734) 560-1144. If you would prefer not to participate you may respond through email or phone. If I do not hear back from you through email or phone, I may attempt to contact you one more time. From there I will assume you'd prefer not to participate.

If you have any questions or concerns, please feel free to contact me at (734) 560-1144, or my advisor Dr. Steven Chatfield at (541) 346-3385.

Thank you for your time. Your input will be extremely valuable not only in the development of this project, but also in the development of resources available to dancers and researchers. I appreciate your consideration and look forward to speaking with you.

Sincerely,

Tiffany A. Taylor

**APPENDIX F**  
**INFORMED CONSENT**

Dear \_\_\_\_\_:

You are invited to participate in a graduate research study conducted by myself, Tiffany A. Taylor, a MFA candidate in the University of Oregon Department of Dance.

The goal of this study is to learn about common dancer injuries and treatments in the hip and low back. You were selected as a possible participant in this study because you are a physical therapist whose work has overlapped in this area.

Participation in this study will consist of a telephone interview. The interview will be recorded and transcribed with the intention to include your name and opinions discussed during the interview. By participating and allowing your thoughts and opinions to be listed with other physical therapists currently working with dancers, you will be represented as an authoritative voice among the dance community aiming to strengthen the link between dance and science. I cannot guarantee however, that you will personally receive any benefits from this research.

Only your name and occupation will be used as identifiers in this research. Your contact information will not be provided.

Your participation is voluntary. This study is being conducted in partial fulfillment of a Masters of Fine Arts Thesis Project. However, your decision whether or not to participate, or the information you provide will not affect your relationship with the University of Oregon. If you decide to participate, you are free to withdraw your consent and discontinue participation at any time.

If you have any questions regarding the study, please feel free to contact me in on my cellular phone at (734) 560-1144. You may also contact my advisor, Dr. Steven Chatfield, at (541) 346-3385. If you have questions regarding your rights as a research subject, please contact the University of Oregon Office for Protection of Human Subjects at (541) 346-2510. This Office will oversee the review of this research to protect your rights. However, the office is not involved with this study.

Your signature indicates that you have read and understand the information provided above, that you willingly agree to participate, that you may withdraw your consent at any time and discontinue participation, that you have received a copy of this form, and that you are not waiving any legal claims, rights or remedies.

## APPENDIX G

### INTERVIEW QUESTIONS AND TOPICS

#### Injury:

Could you provide a list of injuries (limited to the hip and low back) in dancers you have seen or are seeing?

Are these injuries typically acute? Overuse? Etc.

Any trends over the last 2 years? Over your career?

Could you rank the injuries you've treated in order of prevalence?

Do you know of any risk factors or prevalence statistics for these issues?

#### Treatment:

How do you prefer to work? What kind of diagnostic testing tools do you utilize?

Based on your provided injury list, can you provide a list of treatments used?

How many cases are successful with return to activity in one week? Month? Year?

How many cases are not able to return to activity?

How many or what kind of injuries result in surgical procedure?

## REFERENCES

- Amari, Rue, Toshinori Saki, Shinsuke Katoh, Koicki Sairyo, Kosaku Higashino, Keizo Tachibana, and Natsuo Yasui. 2009. Fresh stress fractures of lumbar pedicles in an adolescent male ballet dancer: Case report and literature review. *Archives of Orthopaedic and Trauma Surgery* 129: 397–401
- Anderson, Ruth and Stephanie J. Hanrahan. 2008. Dancing in pain: Pain appraisal and coping in dancers. *Journal of Dance Medicine and Science* 12: 9-16.
- Batson, Glenna. 2007. Revisiting overuse injuries in dance in view of motor learning and somatic models of distributed practice. *Journal of Dance Medicine and Science* 11: 70-75.
- Bronner, Shaw, Sheyi Ojofeitimi, and Lester Mayers. 2006. Comprehensive surveillance of dance injuries: A proposal for uniform reporting guidelines for professional companies. *Journal of Dance Medicine and Science* 10: 69-80.
- Clearman, Rebecca. 1990. Rehabilitation of a Dancer with Recurrent Upper Back and Shoulder Pain: Success with Neuromuscular Re-education. *Medical Problems of Performing Artists* 5: 113-116
- Clippinger, Karen. 2007. The Spine. In *Dance Anatomy and Kinesiology*, 71-155. Champaign: Human Kinetics.
- Fairweather, Malcolm, and Ben Sidaway. 1993. Ideokinetic imagery as a postural development technique. *Research Quarterly for Exercise and Sport* 64: 385-388.
- George, Steven Z., and Anthony Delitto. 2002. Management of the athlete with low back pain. *Clinics in Sports Medicine* 21: 105-120.
- Grossman, Gayanne. 2010. Interview by Author. Telephone Communication. April 21.
- Hamilton, Linda. 2005. Five common dance injuries and how to treat them. *Dance Magazine* 79: 64-71.
- Hartog, Marika, Jo Smith, and Andrea Zujko. 2006. Acetabular labral tears in the dancer: A literature review. *Journal of Dance Medicine and Science* 10: 51-56.



- Humphrey, Amy. 2010. Interview by Author. Telephone Communication. April 13, 20.
- Kocher, Mininder, Ruth Solomon, Minsuk Lee, Lyle J. Micheli, John Solomon, and Allston Stubbs. 2006. Arthroscopic debridement of hip labral tears in dancers. *Journal of Dance Medicine and Science* 10: 99-105.
- Lai, Ruanne Y.J., Donna Krasnow, and Martin Thomas. 2008. Communication between medical practitioners and dancers. *Journal of Dance Medicine and Science* 12: 47-53.
- Liederbach, Marijeanne. 2000. General Considerations for Guiding Dance Injury Rehabilitation. *Journal of Dance Medicine and Science* 4: 54-65
- Liederbach, Marijeanne and Megan Richardson. 2007. The importance of standardized injury reporting in dance. *Journal of Dance Medicine and Science* 11: 45-48.
- Malanga, Gerard. 2009. Diagnostic Tools: X-Ray, Bone Scan, MRI, CT Scan. <http://www.spineuniverse.com/exams-tests/diagnostic-tools-ray-bone-scan-mri-ct-scan> (accessed May 9, 2010)
- McCormack, Moira. 2010. Teaching the Hypermobility Dancer. *The IADMS Bulletin for Teachers* 2: 5-8.
- Micheli, Lyle J., and Christine Curtis. 2006. Stress Fractures in the spine and sacrum. *Clinics in Sports Medicine* 25: 75-88.
- Micheli, Lyle J., and Ruth Solomon. 1997. Treatment of recalcitrant iliopsoas tendinitis in athletes and dancers with corticosteroid injection under fluoroscopy. *Journal of Dance Medicine and Science* 1: 7-11.
- Molnar, Marika. 2010. Interview by Author. Telephone Communication. April 20.
- Rajiah, Prabhakar and Shanmugam Karthikeyan. Metatarsals, Fractures: Imaging. <http://emedicine.medscape.com/article/399372-overview> (accessed May 9, 2010)
- Rip, Blanka, Sylvie Fortin, and Robert J. Vallerand. 2006. The relationship between passion and injury in dance students. *Journal of Dance Medicine and Science* 10: 14-20.
- Scialom, Melina, Aginaldo Gonçalves, and Carlos Roberto Padovani. 2006. Work and Injuries in Dancers: Survey of a Professional Dance Company in Brazil. *Medical Problems of Performing Artists* 21: 29-33.

- Sefcovic, Nadia, and Brenda Critchfield. 2010. First Aid for Dancers. Resource Paper. *International Association of Dance Medicine and Science*.
- Solomon, Ruth. 1999. The 'Cost' of Injuries in a Professional Ballet Company: A Five Year Study. *Journal of Dance Medicine and Science* 3: 34-35.
- Solomon, Ruth, John Solomon, and Sandra Minton. 2005. Iliopsoas Tendonitis in Dancers. In *Preventing Dance Injuries*, 73-78. 2<sup>nd</sup> ed. Champaign: Human Kinetics.
- Spina, Andreo. 2007. External Coxa Saltans (Snapping Hip) Treated with Active Release Techniques®: A Case Report. *Journal of the Canadian Chiropractic Association* 51: 23-29.
- Teitz, Carol C. 2000. Hip and knee injuries in dancers. *Journal of Dance Medicine and Science* 4: 23-29.
- Whipple, Tom, Dean Plafcan and Wayne Sebastianelli. 2004. Manipulative treatment of hip pain in a ballet study. *Journal of Dance Medicine and Science* 8: 53-55.