Ballet Rehabilitation: A Novel Return to Sport Protocol

Laurie Glasser 1, Marie Frey 2, Giulia C. Frias 3, Bobby Varghese 4, Justin X. Melendez 3, Joseph D. Hawes 3, Jared Escobar 3, Brian M. Katt 1

1. Department of Orthopaedic Surgery, Jersey Shore University Medical Center, Neptune, USA 2. Physical Therapy, Ivy Rehabilitation, Toms River, USA 3. Department of Orthopaedic Surgery, Robert Wood Johnson Medical School, New Brunswick, USA 4. Department of Surgery, University of Texas Southwestern Medical Center, Dallas, USA

Corresponding author: Laurie Glasser, lglasser@oiortho.com

Abstract

Dance injuries and re-injuries are common but can be difficult to rehabilitate because of the unique demands and motor skills required. During tissue healing, pain resolves prior to tissue maturation and re-injury often occurs if the original injury is not properly rehabilitated.

The purpose of this narrative review is to analyze the existing literature addressing ballet injury, re-injury, and recovery, and to provide clinicians with timing guidelines for entering and implementing a Return to Sport (RTS) ballet rehabilitation protocol designed to prevent re-injury by progressive, sport-specific tissue loading. Thus far, a literature-based ballet-specific and body region-specific late-stage rehabilitation RTS protocol has not been established. The authors sought to address this literature gap by combining this comprehensive narrative review with our extensive clinical expertise to develop a late-stage rehabilitation RTS protocol to help guide medical clinicians treating injured ballet dancers.

Introduction And Background

Healing and rehabilitation of ballet injuries

One of the many challenges in all of sports medicine is determining when to initiate a return to sport (RTS) protocol, and exactly how to safely progress an athlete back to full participation without re-injury. The purpose of this review is to fill a void in the literature by addressing how and when a medical dance professional (physician or other licensed medical provider) should begin and safely progress a dancer through a ballet-specific RTS protocol. There is a scarcity of information available to assist medical professionals in guiding an injured ballet dancer back toward full participation during late rehabilitation while avoiding re-injury and chronic musculoskeletal issues.

After reviewing the literature, we defined objective criteria to assess a ballet dancer’s readiness to RTS. As set forth in this review, once an injured ballet dancer meets defined criteria, they can qualify to enter a functional RTS phase with our “Return to Ballet Protocol” (Table 1). We found no ballet-specific, body region-specific late-stage rehabilitation protocols; therefore, we developed a protocol to assist medical providers in progressing injured ballet dancers to full participation during the functional (late-stage rehabilitation) RTS protocol to help guide medical clinicians treating injured ballet dancers.

| Foot and Ankle Injury Return to Ballet Protocol (e.g., midtarsal joint sprain, ankle sprain, Achilles tendinitis, anterior ankle impingement, posterior ankle impingement, stress fracture, plantar fasciitis) |
|---|
| Stage 1 For any single leg skills, the injured leg is the working leg. No restrictions on the supporting leg except no fondu. Begin this stage in a sneaker or in a jazz shoe but master all steps without support prior to moving to the next stage. All steps should be completed with barre support first progressing to two-handed support to one-handed support. Progress to center when pain-free. Demi plié limited to half ROM, tendu from 1st position progressing to 5th position when pain-free, rond de jambe a terre, releve on two feet. |
| Stage 2 For any single leg skills, the injured leg is the working leg. No restrictions on the supporting leg. When the injured leg is the working leg, the dancer is cleared for pirouettes, attitude turns, fouetté turns, a la seconde turns, and float turns. No turns with the injured leg as the supporting leg. All steps should be completed with barre support first progressing from two-handed support to one-handed support. Progress to center when pain-free. All steps in stage 1 plus: full demi plie progressing to grande plié as tolerated, degage, frappe on relevé as injured leg does not strike floor, echappé, releve on one foot, bourree, pas de bourree, grande battement, developpé, arabesque, penché. |
| Stage 3 All steps in stage 2 plus: full barre without restriction, fondu with injured leg as supporting leg, non-modified frappe, detourné, chain turn, piqué turn, piqué tour, pique turn, pirouette with injured leg as supporting leg beginning with singles and progressing until previous level is reached (no restriction or pirouette when non-injured leg is supporting leg), attitude turn with injured leg as supporting leg (no restriction or pirouette when non-injured leg is supporting leg). |

How to cite this article

Glasser L, Frey M, Frias G C, et al. (August 11, 2022) Ballet Rehabilitation: A Novel Return to Sport Protocol. Cureus 14(8): e27896. DOI 10.7759/cureus.27896
| Stage | All steps in stage 3 plus: fouetté turns with injured leg as supporting leg, à la seconde turns with injured leg as supporting leg, float turns with injured leg as supporting leg, glissade, chassé, pas de chat, soubrelevé, changement (no beats). |
|-------|-------------------------------------------------------------------------------------------------|
| Stage 4 | All steps in stage 4 plus: sissonne, assemblé, jumpe avec beats, all petit allégros except temps levé. |
| Stage 5 | All steps in stage 5 plus: grande jeté, tour jeté, saut de chat, temps levé. Return to partner work. Pointe work can be started after pain-free completion of this stage. |
| Stage 6 | All steps in stage 5 plus: saut de chat, sissonne landing on injured leg, grande jeté, tour jeté. Return to partner work. Pointe work can be started after pain-free completion of this stage. |

**Knee Injury Return to Ballet Protocol (e.g., patellofemoral syndrome, patellar tendinitis, quad tendinitis/itis, Osgood Schlatter, ACL tear, MCL sprain or tear, MPFL tear, meniscal tear, posterior capsulitis)**

| Stage 1 | For any single leg skills, the injured leg is the working leg. No restrictions on the supporting leg except no fondus. All steps should be completed with barre support first progressing from two-handed support to one-handed support. Progress to center when pain free. Tendu, rond de jambe terne, grande battement, développé, arabesque, penché, bournèe, pas de bournèe, demi plié in first and second position, grande pliés in second position, dégagé, frappé, échappé, relevé in first and second position. |
| Stage 2 | When the injured leg is the working leg, the dancer is cleared for pirouettes, a à la seconde turns, and float turns. No turns with injured leg as supporting leg. All steps in stage 1 plus: demi and grande pliés in all positions, détourné, rond de jambe en l’air at 45 degrees progressing to 90 degrees then dancer’s end range with the injured leg as the working leg. No restriction on the supporting leg (unless pain). |
| Stage 3 | When the injured leg is the working leg, the dancer is cleared for turns from stage 2 plus attitude turns and fouetté turns. All steps in stage 2 plus: full barre without restriction, include fondus with injured leg as supporting, sissonne landing on uninjured leg, chainé turns, pirouettes with injured leg as supporting-leg beginning with singles and progressing until previous level is reached (no restriction with pirouette when non-injured leg is supporting leg), attitude turns. |
| Stage 4 | All steps in stage 3 plus: piqué turns, fouetté turns, a la seconde turns, float turns, soubrelevé, changement, pas de chat, glissade, chassé. |
| Stage 5 | All steps in stage 4 plus: assemblé, temps levé, all petit allégros |
| Stage 6 | All steps in stage 5 plus: saut de chat, sissonne landing on injured leg, grande jeté, tour jeté. Return to partner work. Pointe work can be started after pain-free completion of this stage. |

**Anterior Hip Injury Return to Ballet Protocol (e.g., snapping hip, hip flexor strain or tendinitis, bony avulsions, impingement, sartorius enthesopathy, hip labral tear, hip OJD, femoral neck stress fracture)**

| Stage 1 | All steps should be completed with barre support first progressing from two-handed support to one-handed support. Progress to center when pain free. Relevé, détourné, demi plié in all positions, bournèe, pas de bournèe, échappé, fondu. |
| Stage 2 | When the injured leg is the supporting leg, the dancer is cleared for pirouettes, attitude turns, fouetté turns, à la seconde turns, and float turns. No turns with injured leg as working leg. All steps in stage 1 plus: rond de jambe à terre, grande pliés in all positions, chainè turns, piqué turns, glissade, chassé, passé, frappé, dégagé. |
| Stage 3 | All steps in stage 2 plus: pirouettes with injured leg as working leg, pas de chat, temps levé, assemblé, sissonne, rond de jambe en l’air at 45 degrees, penché with injured leg as the working leg, arabesque, changement, soubrelevé. |
| Stage 4 | All steps in stage 3 plus: grands battements to 90 degrees with the injured leg as the working leg (no restriction on the supporting leg), développé to 90 degrees with the injured leg as the working leg (no restriction on the supporting leg), rond de jambe en l’air at 45 degrees progressing to 90 degrees then dancer’s end range with the injured leg as the working leg. No restriction on the supporting leg (unless pain). |
| Stage 5 | All steps in stage 4 plus: grand battement at dancer’s end range, développé at dancer’s end range, rond de jambe en l’air at dancer’s end range, attitude turns, fouetté turns, a la seconde turns, float turns. |
| Stage 6 | All steps in stage 5 plus: saut de chat, grande jeté, tour jeté. Return to partner work. Pointe work can be started after pain-free completion of this stage. |

**Posterior Hip Injury Return to Ballet Protocol (e.g., piriformis or obturator internus strain)**

| Stage 1 | All steps should be completed with barre support first progressing from two-handed support to one-handed support. Progress to center when pain free. Limit turnout to pain-free range relevé, demi plié in first and second positions, grande pliés in first and second positions, fondus from first position, bournèe, pas de bournèe, échappé, passé, rond de jambe à terre, chainè turns, changement. |
| Stage 2 | When the injured leg is the supporting leg, the dancer is cleared for pirouettes, attitude turns, fouetté turns, à la seconde turns, and float turns. No turns with injured leg as working leg. All steps in stage 1 plus: détourné, demi plié in all positions, grande plié in all positions, fondus from 5th position, dégagé, frappé, piqué turns. |
| Stage 3 | All steps in stage 2 plus: grande battement, développé, pirouettes with injured leg as working leg, glissade, pas de chat, assemblé, sissonne, changement, soubrelevé. |
| Stage 4 | All steps in stage 3 plus: fouetté turns with injured leg as working-leg, a la seconde turns with injured leg as working leg, float turns with injured leg as working leg, penché with injured leg as support leg. |
| Stage 5 | All steps in stage 4 plus: rond de jambe en l’air, attitude turns, penché with injured leg as working leg, arabesque. |
| Stage 6 | All steps in stage 5 plus: saut de chat, grand jeté, tour jeté. Return to partner work. Pointe work can be started after pain-free completion of this stage. |
# Hamstring Injury Return to Ballet Protocol

| Stage  | Steps |
|--------|-------|
| 1      | All steps should be completed with barre support first progressing from two-handed support to one-handed support. Progress to center when pain-free. Relévé, détourné, demi plié, grande plié, fondu, bournée, pas de bournée, rond de jambe a terre, passé, chambé turn, pienettes. |
| 2      | All steps in stage 1 plus: soubresaut, changement without beats, piquet turn, échapé, dégagé, chassé, pas de chat, soubresaut. |
| 3      | All steps in stage 2 plus: changement with beats, rond de jambe en l’air at 45 degrees, développé to 90 degrees, arabesque to 90 degrees, a la seconde turns, float turn. |
| 4      | All steps in stage 3 plus: développé to dancer’s end range, battement, penché at half of normal extension, assemblé, sissonne, rond de jambe en l’air to 90 degrees, temps levé. |
| 5      | All steps in stage 4 plus: rond de jambe en l’air to dancer’s end range, full extension penché. |
| 6      | All steps in stage 5 plus: saut de chat, grande jeté, tour jeté. Return to partner work. Pointe work can be started after pain-free completion of this stage. |

# Back-Extension Injury Return to Ballet Protocol

| Stage  | Steps |
|--------|-------|
| 1      | All steps should be completed with barre support first progressing from two-handed support to one-handed support. Progress to center when pain-free. All pliés, détourné, tendu, rond de jambe a terre, dégagé, frappé, fondu, échapé, battement devant and to the side, développé devant and to the side, cambé to the front, attitude devant, bournée, pas de bournée. |
| 2      | All steps in stage 1 plus: cambé to the side, pienettes, chambé turn, piquet turns, fouetté turns, a la seconde turns, float turns. |
| 3      | All steps in stage 2 plus: arabesque to 45 degrees, chassé, glissade, pas de chat. |
| 4      | All steps in stage 3 plus: penché through 50% ROM, arabesque to 90 degrees, battement derrière and to the side, développé derrière and to the side, cambé to the back, attitude derrière, penché, pas de bournée. |
| 5      | All steps in stage 4 plus: cambé to the back, penché through full range, arabesque to full range, attitude turns, soubresaut, changement, sissonne, assemblé, temps levé. |
| 6      | All steps in stage 5 plus: saut de chat, grande jeté, tour jeté. Return to partner work. Pointe work can be started after pain-free completion of this stage. |

# Back-Flexion Injury Return to Ballet Protocol

| Stage  | Steps |
|--------|-------|
| 1      | All steps should be completed with barre support first progressing from two-handed support to one-handed support. Progress to center when pain-free. All pliés, détourné, tendu, rond de jambe a terre, dégagé, frappé, fondu, échapé, battement derrière and to the side, développé derrière and to the side, cambé to the back, attitude derrière, bournée, pas de bournée. |
| 2      | All steps in stage 1 plus: cambé to the side, pienettes, chambé turn, piquet turns, fouetté turns, a la seconde e turns, float turns. |
| 3      | All steps in stage 2 plus: attitude devant, piquet turns, attitude turns, chassé, glissade, pas de chat, battement devant and to the side, développé devant and to the side, cambé to the back, attitude derrière, penché, pas de bournée. |
| 4      | All steps in stage 3 plus: fouetté turns, a la seconde turns, float turns, rond de jambe en l’air, battement devant and to the side, développé devant and to the side, cambé to the back, attitude derrière, penché, pas de bournée. |
| 5      | All steps in stage 4 plus: cambé to the front, soubresaut, changement, sissonne, assemblé, temps levé. |
| 6      | All steps in stage 5 plus: saut de chat, grande jeté, tour jeté. Return to partner work. Pointe work can be started after pain-free completion of this stage. |

# Neck Injury Return to Ballet Protocol

| Stage  | Steps |
|--------|-------|
| 1      | All steps should be completed with barre support first progressing from two-handed support to one-handed support. Consider using a scarf around the neck during warm-up. All barre, no restriction except no cambé (i.e., no turns, no jumps). |
| 2      | All steps in stage 1 plus: cambé side and front, détourné. |
| 3      | All steps in stage 2 plus: cambé back, soubresaut, changement, sissonne, assemblé, temps levé. |
| 4      | All steps in stage 3 plus: saut de chat, grande jeté, tour jeté. |
Stage 5
All steps in stage 4 plus: all turns: start with single turns and progress when pain-free (pirouettes, fouetté turns, a la seconde turns, float turns, attitude turns, piqué turns, chainé turns).

Stage 6
All steps in stage 5 plus: return to partner work.

### TABLE 1: Return to Ballet Protocol

| Term            | Definition                                                                 |
|-----------------|-----------------------------------------------------------------------------|
| A la seconde turn | A turn where the working leg is abducted to 90 degrees while remaining turned out. The supporting leg pliés between turns. |
| Allégro         | Fast steps and jumping movements in center. Petite allégro are smaller jumps such as petit assemblés and jetés, medium allégro includes sissones and entrechat cotes and grande allégro typically includes grande jetés, cabrioles, fouettés en l’air, saut de chat. |
| Arabesque       | Standing on one leg with the other leg extended back in the air with a straight knee. |
| Assemblé        | A jump from one foot landing on two feet.                                   |
| Attitude        | Movement including extension or flexion at hip with knee flexion.          |
| Cambré          | To bend at the waist either forward or backward.                            |
| Chainé turns    | “To chain”. It is a traveling turn with quick, connected small steps alternating between feet. Connected chainé turns are “chained” together. |
| Changement      | “To change”. It is a jump using both feet where the dancer begins in 5th position in plié, jumps up with straight legs, switches legs and ends in 5th position with the opposite foot in front. |
| Chassé          | One foot gliding forward leading with the toes, the second leg then quickly shoots in to meet it. |
| Degagé          | “To disengage”. This involves extending the leg while pointing the foot slightly off the floor and then more forcefully bringing the leg back in. |
| Demi            | “Small”.                                                                   |
| Dernière        | “To the back”                                                               |
| Devant          | “To the front”.                                                             |
| Développé       | “To unfold”. Large lower extremity movement where working leg is moved into knee flexion to supporting leg and then into extension in the open position in the air. |
| Echappé         | “To escape”. The feet slide from one position, usually fifth, out to another position (second or fourth) then back to the starting position. |
| En l’air        | “In the air”.                                                               |
| En tournant     | “To turn”.                                                                 |
| Float turns     | Turns with the leg flexed at the hip and extended at the knee in second position. Turns which are performed without lowering to plié between turns. |
| Fondu           | “To melt”. Demi plié on one leg.                                            |
| Fouetté         | A pirouette (turn) performed with a circular whipping movement of the gesture leg extending and then flexing with the foot returning to touch the supporting knee. |
| Frappé          | “To strike”. The working leg is flexed in front of the ankle, shafts out to strike the floor, then comes back in flexed behind the ankle. |
| Glissade        | “To glide”. It is a traveling, usually small, jump that is used to link other steps together. |
| Grande          | “Large”                                                                     |
| Grande          | A kick or lift of the leg in the air flexed at hip and extended at knees.   |

Our protocol uses the language of ballet; however, we believe it could potentially be extrapolated to be used for modern, contemporary, and jazz dancers. This dance-specific, late-stage rehabilitation protocol was developed based on review of the general sports medical literature, review of expert opinion, and the lead author’s (physician, LG) and second author’s (physical therapist, MF) extensive clinical experiences in dance injury practices.

A glossary of common ballet terms is included in Table 2[14].

---

2022 Glasser et al. Cureus 14(8): e27896. DOI 10.7759/cureus.27896
| Ballet Term | Definition |
|-------------|------------|
| Jeté        | “To throw”. It is a jump from one foot to the other with the working leg moving through battement. |
| Pas de bourrée | Three small steps alternating the feet moving back, to the side, then to the front. |
| Pas de chat  | “Cat’s step”. A jump from one foot to the other where each leg moves through passé. There is a moment in the air where both legs are in high passé with pointed feet. There are variations in 4\textsuperscript{th} and 5\textsuperscript{th} positions. |
| Passé       | “To pass through” from one position to another. |
| Penché      | “Leaning”. It is a position with the working leg in arabesque and the torso leaning forward. The height of the arabesque is often idealized so that the standing leg and working leg are at 180 degrees. |
| Piqué turns | “Pricking”. It describes the entry into the turn where the dancer steps directly into full pointe or high demi pointe as they begin the turn with an extended knee. The working/gesture leg may be in any position including arabesque, attitude, etc. |
| Pirouette   | A turn on one foot with the raised foot of the gesture leg touching the knee of the support leg. |
| Plié        | A bend at the knees and ankles. |
| Port de bras | “Movement of the arms”. This describes how a dancer moves their arms from one position to another. |
| Dance Positions | All positions are performed in turnout with fully extended knees. 1\textsuperscript{st} position is standing with the heels together, 2\textsuperscript{nd} position is standing with the feet next to each other but apart, 3\textsuperscript{rd} position is standing with the heel of one foot next to the arch of the other foot, 4\textsuperscript{th} position is standing with one foot in front of the other but apart, and 5\textsuperscript{th} position is standing with the heel of one foot next to the toes of the other foot. |
| Relevé      | “To rise”. The dancer’s weight is on the balls of the feet at the MTP joint or on the toes if the dancer is in appropriate shoe wear. |
| Rond de jambes | Circular movement of the leg. |
| Saut de chat | “Cat’s jump”. A jump from one foot to the other with the leading leg moving through développé and at the height of the jump in air the dancer is in the split position. |
| Sauté       | A jump from two feet landing on two feet. |
| Sissonne    | A jump from two feet landing on one foot. |
| Soustresaut | A jump from two feet landing in 5\textsuperscript{th} position. |
| Support leg | Weightbearing leg. |
| Temps levé  | A jump from one foot landing on the same foot. |
| Tendu       | Leg extension with a pointed foot where the foot remains in contact with the ground. |
| Tour jeté   | A grande jeté performed while turning so the dancer lands the jump in arabesque facing the direction they came from. |
| Turn out    | Ballet technique where hips are externally rotated. |
| Working leg | Non-weight-bearing leg, also referred to as the gesture leg. |

**TABLE 2: Ballet Term Glossary**

MTP: metatarsophalangeal [14].

---

**The Fundamental Phases of Healing**

An understanding of the basic science of tissue healing and rehabilitation is required to explain the importance of a proper progressive, late-stage rehabilitation RTS program in ballet. To summarize, the three phases of tissue healing are: inflammation, repair (proliferative), and maturation (remodeling) [3,16].

The inflammation phase lasts approximately 5-14 days and is characterized by bleeding, hemostasis, and platelet granulation. This phase initiates the healing process by attracting local stem cells to the area and is distinguished by pain, edema, warmth, and dysfunction. Extremes of inflammation, insufficient or excessive, can result in inadequate or incomplete healing [3,16].

The repair (proliferative) phase is the second phase of tissue healing. While the timing of all the phases overlaps to some extent, the second phase of healing lasts for weeks to months and is defined by neovascularization, the formation of type three (immature) collagen, and the formation of fibroblasts and
growth factors which promote cellular healing. Although pain resolves during this phase, re-injury is common because the healing tissue does not have the same tensile strength as mature tissue [3,16].

The maturation (remodeling) phase, or the third phase of healing, involves the conversion of type three (immature) collagen, to type one (mature) collagen and can occur from weeks after an injury to one year. This phase also results in collagen fiber realignment in response to load, emphasizing the importance of appropriate, progressive loading in late rehabilitation. The maturation (remodeling) phase of tissue healing is also associated with reduced cellularity and vascularity, cross-linking of the mature collagen fibers, and scar tissue maturation. Tissue healing continues well past the resolution of the patient’s symptoms; therefore, proper rehabilitation and correction of underlying form defects as well as strength and neuromuscular control imbalances are critical in preventing re-injury [3,16].

It is further beneficial to consider the approach to the rehabilitation of a ballet dancer in three stages: the acute phase, the recovery phase, and the functional RTS phase, also referred to as late-stage rehabilitation [4]. The stages of rehabilitation correlate with the stages of tissue healing described above.

The acute phase of rehabilitation parallels the inflammatory phase of healing; therefore, pain and edema control are the primary goals during this phase. This is the shortest phase of the rehabilitation pathway [6,8,22-24].

The recovery phase of ballet injury rehabilitation involves the restoration of fitness characteristics such as motion, strength, and endurance. This phase can be thought of as basic rehabilitation. It parallels the repair (proliferative) phase as well as components of the maturation (remodeling) phase of tissue healing. Goals during this phase of rehabilitation not only include restoring fitness parameters mentioned above but also treating neuromuscular and biomechanical deficits in motor control that influence performance [6,8,22-24].

Finally, the third and final phase of rehabilitation is the functional phase, also known as late-stage rehabilitation. Late-stage rehabilitation immediately follows the completion of basic rehabilitation. The primary goal during this phase is to prepare the athlete for RTS. This phase corresponds to the later part of tissue remodeling and is also known as the maturation phase of healing. The rehabilitation goals during this functional phase include controlled, progressive increases in sports-specific demands [2,9,25]. Dance medicine professionals need validated late-stage rehabilitation protocols with controlled, progressive increases in ballet-specific demands to assist ballet dancers in safely returning to their sport during the functional phase of rehabilitation after completion of the recovery phase of rehabilitation [4].

Review

Method of literature search

Search Strategy

A broad database search of MedLine, PubMed, CINHAL, and Cochrane Library was performed on June 22, 2022, using keyword combinations to search the literature for key aspects relevant to our area of interest. The following search terms were entered for our review: “dance injur*” or “ballet injur*”; “return to sport” or “return to play”; “dance rehabilitation”; and “reinjur* in sport,” to identify suitable articles for this review. The complete search strategy is presented in Figure 1.
Evidence Acquisition

Our database search (MedLine, PubMed, CINHAL, and Cochrane Library) yielded a total of 9009 records. Additionally, review articles were scanned, and the bibliographies of all articles were thoroughly examined for additional studies pertinent to the topic of the review. We removed 271 duplicates. We excluded 5570 articles not published in English, and all articles based on non-human subjects. A filter was applied for publication dates within the last 12 years. The remaining 3168 articles were divided equally between eight reviewers who worked independently to collate data based on study type and reported conclusions. The Oxford Centre for Evidence-Based Medicine Levels of Evidence (LOE) tool was used to assess the level of evidence in studies.

Evidence Synthesis

For ballet injury, re-injury, recovery, and generalized timing guidelines for RTS, we prioritized clinical trials (randomized and non-randomized control trials), cohort and cross-sectional designs, meta-analyses, and systematic reviews. The studies were assessed for clear study designs with unambiguous inclusion and exclusion criteria as well as for information about ballet injury, criteria affecting re-injury in sport, readiness to RTS, and any specific late rehabilitation protocols. The reference sections suggested one book chapter that was not identified in the primary search and was included. We excluded 1573 low-level studies including all level IV evidence (case series and case reports).

Though our search revealed generalized evidence-based studies informing our discussion of ballet injury, re-injury, recovery, and the initiation of sports-specific movements (RTS), the search failed to uncover evidence-based studies with ballet-and-body region-specific RTS rehabilitation protocols. Therefore, the remaining 1595 records were evaluated by three reviewers (LG, GF and BV) to determine final inclusion based upon the inclusion of re-injury factors, any relevant late rehabilitation (RTS) or movement re-training methods, and body areas of interest (e.g., spine and lower extremity injuries). Articles that pertained to body areas not of interest (e.g., concussion, wrist, elbow, shoulder, hand) and articles not relating to RTS, rehabilitation methods, injury, or re-injury were excluded. Studies were also excluded if they only focused...
on the immediate post-surgery period and did not discuss the subsequent later rehabilitation with a sports-specific ramp-up. The investigators discussed the articles while considering the inclusion and exclusion criteria until 100% agreement was achieved. In seeking high-level articles relating to ballet injuries and when to start sports-specific movement, level of evidence and scope of inquiry were key components when determining final inclusion. Any conflicts were resolved with discussion. As such, we included 18 Level V studies (expert opinions, narrative reviews, consensus statements, and book chapters) referencing RTS rehabilitation protocols to aid in the development of our novel “Return to Ballet” protocol. This review identified 69 articles that met the pre-specified search criteria. There were three RCTs, 22 systematic reviews/meta-analyses, 15 cohort studies (11 prospective, four retrospective), 11 cross-sectional studies, 15 narrative reviews/consensus statements, and three book chapters (Figure 1).

The need for a ballet-specific return to sport protocol

Being both a sport and a performance art, ballet is highly physical, technically demanding, and has unique rehabilitation requirements [26]. It is reported that 95% of ballet dancers are injured during their careers, with an injury rate of 0.6-4.6 per 1000 exposure hours, which for many ballet dancers, correlates to 25-50 weeks of participation [27-32]. This wide range of injury rates reflects not only novice to professional status, but also differences in how injury is defined, emphasizing the need for reporting standardization [17,33]. Seventy-five percent of ballet injuries are overuse versus acute trauma and most often, involve the lower extremities, especially the foot and ankle [33,34]. The second most common group of injuries in ballet involves the spine, with a high rate of thoracic and lumbar type pain [21,26,35]. Table 3 summarizes common dance injuries and technical considerations in returning to sport.

| Body part | Injury | Dance-specific considerations |
|-----------|--------|------------------------------|
| Hip       | Snapping hip, Hip flexor | Tight ITB can limit the range of motion of adduction and stretching may be indicated. Many ballet dancers are weakest at the end ranges of motion and “throw” themselves into large end range leg flexion movement with uncontrolled hip hiking in positions such as grande battement and développé instead of controlling motion through the end-range. |
| Hip       | FHL tenosynovitis | The FHL becomes compressed in the proximal margin of the fibro-osseous tunnel along the posterior medial talus under the sustentaculum talus. Pointe shoes change the anatomic positioning and cause the ankle invertor and evertors to be plantar flexors as well as dynamic stabilizers of the ankle. |
| Hip       | Burissia, Hip capsulitis, Hallux valgus | On-pointe bone forces on the MTP joint are up to 12 times the dancer’s body weight (these forces are greater with errors in technique). Weight on the great toe is estimated at 20 kg/cm. |
| Hip       | Iliofemoral joint sprain | A common correctable misconception of many ballet dancers is the belief that forcing the forefoot into greater equines by bending the supporting knee with the weight of the body on the dorsum of the opposite foot at barre improves pointe. |
| Hip       | Anterior ankle impingement | The ballet dancer will usually report pain with forceful or repeated plantar flexion, especially on pointe. Check for os trigonum. Treatment of this injury may require excision. |
| Hip       | Stress fracture of foot and lower leg | Most commonly involves proximal 2nd and 3rd MT, base of 5th MT, navicular, sesamoid, midshaft tibia, and distal fibula. Assess control of landing and floor type. Ensure proper warm-up alignment, foot care, and assess for RED-o. |
| Hip       | Strain of medial head of gastrocnemius at the musculotendinous junction | Assess for a proper dynamic warm-up and strengthening once healed. |
| Hip       | Plantar fascitis | A common injury resulting from forced turnout. Check for irregular landing mechanics especially pronation on landing. |
| Hip       | Peripheral nerve compression | Most commonly includes dorsal cutaneous compression, sural neuritis, and Morton’s neuroma. Check the fit of pointe shoes. |
| Hip       | Onycholyis Parsychia | Protect nail with polish or taping. Avoid removing toenail as nails are critical to a ballet dancer. The preferred treatment is soaking, elevation, and antibiotics. Check the fit of pointe shoes, change the brand of shoes if necessary, and assess the floor surface. |
| Hip       | Piriformis/obturator internus strain | Ballet dancers often overuse hip external rotators when hip abductors are not engaged in stability. |
| Foot and ankle | Achilles tendinitis | Injury risk increases with too little ankle dorsiflexion, hard landings, and excessive pronation on landing. |
| Foot and ankle | Anterior ankle impingement | The ballet dancer will usually report feeling “stuck” with demi-plié and painful dorsiflexion from either soft tissue inflammation or tibio-talal osteophyte formation. Treatment of this injury may involve surgery. |
| Foot and ankle | Posterior ankle impingement | The ballet dancer will usually report pain with forceful or repeated plantar flexion, especially on pointe. Check for os trigonum. Treatment of this injury may require excision. |
| Foot and ankle | Stress fracture of foot and lower leg | Most commonly involves proximal 2nd and 3rd MT, base of 5th MT, navicular, sesamoid, midshaft tibia, and distal fibula. Assess control of landing and floor type. Ensure proper warm-up alignment, foot care, and assess for RED-o. |
| Foot and ankle | Strain of medial head of gastrocnemius at the musculotendinous junction | Assess for a proper dynamic warm-up and strengthening once healed. |
| Foot and ankle | Plantar fascitis | A common injury resulting from forced turnout. Check for irregular landing mechanics especially pronation on landing. |
| Foot and ankle | Peripheral nerve compression | Most commonly includes dorsal cutaneous compression, sural neuritis, and Morton’s neuroma. Check the fit of pointe shoes. |
| Foot and ankle | Onycholyis Parsychia | Protect nail with polish or taping. Avoid removing toenail as nails are critical to a ballet dancer. The preferred treatment is soaking, elevation, and antibiotics. Check the fit of pointe shoes, change the brand of shoes if necessary, and assess the floor surface. |
| Foot and ankle | Piriformis/obturator internus strain | Ballet dancers often overuse hip external rotators when hip abductors are not engaged in stability. |
| Foot and ankle | Snapping hip, Hip flexor tendinitis, bony avulsions, sub-spine impingement, sartorius enthesopathy, hip labral tear, hip DJD | Tight ITB can limit the range of motion of adduction and stretching may be indicated. Many ballet dancers are weakest at the end ranges of motion and “throw” themselves into large end range leg flexion movement with uncontrolled hip hiking in positions such as grande battement and développé instead of controlling motion through the end-range. |
### TABLE 3: Common Ballet Injuries and Ballet Specific Considerations

| Injury Type | Considerations |
|-------------|-----------------|
| Lumber strain/pain/spondylolisthesis | The most common dysfunctional movement pattern associated with back pain is increased force across the lumbar spine from an inability to extend the hip without spinal compensation. Back pain can be associated with decreased thoracic, shoulder and/or hip mobility and is often seen in Arabesque positions where the dancer is over firing lumbar muscles instead of properly using the posterior chain (e.g., the gluteus maximus and hamstrings). During growth spurts, hyper-lordosis can occur from increased lumbar lordosis. Often, the ballet dancer assumes this position while their knees are bent in plié and then straightens their knees with fixed feet using the friction of the floor. This improper and potentially injury-inducing movement pattern is referred to as "bottom-up" turnout. A dancer should be able to slide from parallel into first position without lifting their feet off the floor to avoid "forced turnout". The dancer can be instructed to use turnout discs to train their deep hip external rotators. Assess the dynamic position of the knees during landing/squatting and correct valgus or transversus abdominis activation issues, hip-flexor tightness, poor hip adductor and/or hip adductor recruitment. |
| Patellar tendonitis/synovitis | Address the ballet dancer's landing mechanics. Correct high vertical and braking ground reaction forces during landing. |
| Osgood Schlatter Syndrome | Ensure the ballet dancer is achieving alignment over the pointe shoe toe-box. Check for overly worn/"dead" pointe shoes which collapse and don't support the dancer. |
| ACL injury | The low rate of non-contact ACL injuries in ballet can be explained by the turnout position which requires greater gluteus activation and decreased knee adduction as compared to many other sports. However, in the case of ACL reconstruction surgery, if the ballet dancer suffers even minimal loss of terminal knee extension, it is often career-ending. |
| Meniscal tear | Ballet dancers can have meniscal tears with a rotational force on the knee. Meniscal repair is the most common surgical procedure related to a dance injury. |
| Patellar tendonitis/synovitis | Ensure transversus abdominis activation is present throughout the movement. Check for forced turnout as this aberrant pattern is associated with lumbar compensation. The dancer should achieve turnout by firing the deep hip external rotators, while exhibiting a neutral lombo-shoulder, thoracic spine, lumbar spine, and hips. Ensure that transversus abdominis activation is present throughout the movement. Check for forced turnout as this aberrant pattern is associated with lumbar compensation. The dancer should achieve turnout by firing the deep hip external rotators, while exhibiting a neutral lumbo-pelvic alignment and avoiding over-turning and gripping of quad and gluteus. The dancer should avoid excessive knee hyperextension and foot pronation with turnout. |

There are literature-based generalized RTS guidelines attempting to direct when athletes can begin sports-specific skills. For example, Serner et al. (2020) concluded that soccer players who successfully completed criteria-based exercise testing to define the end of their basic rehabilitation (recovery) phase prior to starting the functional (RTS/late rehabilitation) phase, had a significantly lower re-injury rate than athletes who did not [25]. However, the available protocols directing when to start sports-specific movements are not specific to ballet [5-10,18,23,25,26,45-50]. For ballet dancers returning from injury, there is a need for validated criteria to determine when a ballet dancer is ready to begin RTS and protocols to safely direct the dancer to full participation.

The few RTS dance protocols that have been reported in the literature do not include specific body regions or ballet-specific skills and focus more on generalized principles of balance, jumping and turning, with instructions to progress from barre work, to center, to small jumps, to large jumps, to pointe, and then to partner work [14,15,17]. While this type of generalized approach can be helpful, it fails to address the nuances of how injury to a specific body region may affect the dancer’s ability to correctly and safely execute certain ballet skills. Likewise, these generalized RTS principles lack insight into how a dance medicine clinician should subsequently begin to incorporate and progress certain ballet-specific movements depending on the injured body region. Our “Return to Ballet Protocol” is unique in that it expands upon the aforementioned generic dance progression in its careful consideration for both ballet- and body-region-specific movements in progressing RTS protocol. For example, generic return to dance protocols advise ballet dancers to resume barre work as the initial step in returning to sport during late rehabilitation. However, a frappé, a step almost exclusively done at the barre, would be an inappropriate and potentially dangerous initial sports-specific skill for a dancer returning to sport following a foot injury. For this reason, our Foot and Ankle Return to Ballet Protocol (Table 1) advises that the dancer resume most barre work but should avoid striking the injured foot against the floor by performing frappé on relevé in stage 2 before safely progressing to a non-modified frappé in stage 3.
The high re-injury rate seen in ballet can be explained, in part, by a lack of sports-specific direction during this vulnerable period of healing following the resolution of pain but before the tensile strength of the injured, immature connective tissue returns to pre-injury levels [6,8,23,25,46,51]. Our “Return to Ballet Protocol” uses a systematic, loading rehabilitation process in an ordered, ballet-specific sequence of skills to assist medical providers in making complex clinical decisions associated with ramping up ballet dancers back to full participation during the functional (late-stage rehabilitation) RTS phase [23]. No evidence-based study thus far has addressed a late-stage rehabilitation protocol during this critical, but often neglected, phase of rehabilitation. A ballet-specific RTS protocol allows the dancer to prepare for the sport’s specific demands in order to maximize safe re-entry into ballet and to decrease re-injury rates [6,51]. As our literature review did not uncover any body region-specific, validated return to ballet protocols, the progressive stages of our protocol were created based on the review of the general sports medicine literature, knowledge of the biomechanical principles of ballet skills, review of expert opinions, and our extensive clinical experience [5,8-10,14,15,25].

Factors contributing to ballet injuries

A goal for a sports medicine provider is to identify the factors impacting recovery from dance injuries. As injury risk is multifactorial, there are multiple strategies that may serve to reduce injury rates and re-injury risk [29,36,37,39]. As many dancers begin their training at a very young age, their early specialization is often associated with no off-season for physical and mental rest [52]. It is common for ballet dancers to increase training hours too quickly as they advance in training, often up to 20-40 hours per week, not including performances. Fatigue, burnout, and technique errors often result [52,53]. This high training load usually coincides with developmental changes associated with growth and puberty, further increasing injury risk [10]. If dance culture were reformed to teach ballet dancers to heed their internal warning signs and to avoid excessive training and burnout, the overuse injury rate would most likely decrease [29,35,38,40,54].

Ekegren’s systematic review reports a study where a high proportion of dancers sustained injuries before age 18 that ultimately ended their young careers [28].

Ballet can sometimes demand biomechanically disadvantageous body positions that may result in injury and motor system dysfunction. A dancer’s attempt to achieve a specific “shape” or aesthetic ideal for choreography can push them past their anatomical limitations [33]. Lower extremity injury rates decrease when dancers are screened for femoral anteversion, genu varum and valgum, tibial torsion, and pes cavus and are then trained to work within their individual limitations [17,24,35,53]. As the risk of a lower extremity injury among dancers is substantially increased by a lack of ankle dorsiflexion, improving ankle dorsiflexion decreases injury risk [55]. There are multiple studies in the dance science literature that associate increased injury risk in dancers with lower muscle strength [26,56], but a systematic review by Moita et al. (2017) argues against this, concluding that improved muscle strength in dancers was not protective against injury. Conclusions reached by Moita are muddied by the fact that most dance studies included in the review did not clearly define injury and included incomplete and non-dance-specific measurements for muscular endurance and strength [41].

Injury risk decreases when a ballet dancer refrains from alcohol and cigarette use [26,53]. Practices and performances on even, sprung (suspended) floor types result in lower forces on the dancers’ extremities and therefore, fewer injuries [32,53]. Injuries are also reduced when pointe shoes are replaced before they structurally deteriorate and lose the ability to provide ankle and foot support [24,37].

One of the leading risk factors for ballet-related injuries and re-injuries is improper execution of turnout, a defining dance position. Technically correct turnout is achieved primarily through hip external rotation which then directs lower extremity position at the knee, ankle, and foot [42]. Forced turnout is a compensatory movement pattern specific to dancers, especially in ballet, where dancers with anteverted hips, or tight hip flexors, attempt to increase the degree of foot external rotation by using the friction of the floor against their feet instead of using their deep hip external rotators. The result of this aberrant movement pattern includes torsional strains and various overuse injuries such as patellofemoral pain and lower leg and foot tendonitis [24]. Educating ballet dancers to activate their deep hip external rotators and to stay within their anatomic limitations is important in preventing turnout overuse injuries [36]. “Rotation disks” can be useful in this situation because they teach the dancers the correct technique of activating their hip rotators in turnout [14,17,24].

Given that up to 58% of ballet dancers born female have hypermobility syndromes, special precautions should be taken in this group of dancers to reduce injury rates to their slower healing, more vulnerable connective tissue [14,24,56]. The hypermobile athlete does not benefit from standard flexibility work. Uncontrolled, extreme range of motion coupled with high forces and frequent repetition is not beneficial for any athlete and is especially damaging for a hypermobile dancer. When a hypermobile ballet dancer extends past their anatomic limitations, the joint capsule is stretched rather than the muscle-tendon unit, and the protective neural response to the resulting microtrauma can paradoxically reduce mobility [14,15,57]. At extreme ranges of motion, the hypermobile athlete’s joints often sublux and lead to joint instability, shoulder and hip labral tears, and permanent capsular laxity. Using a ballet-specific rehabilitation protocol to ramp up to full participation after injury is even more important for this group of athletes [14,24,58].
Factors contributing to re-injury in ballet

With the rate of re-injury reported at 30% depending on sport and body part, avoidance of re-injury is key for the healing athlete [6,51]. Most subsequent injuries occur within two months of the initial injury [11,22]. Of these re-injuries, up to 14% affect the same area, and up to 75% will affect a different location [25,32,51,59]. Dance medicine is most effective when rehabilitation treatments focus on functional movement patterns and neural adaptations rather than just the focal injury [5,24,32,37]. Patients with the poorest functional outcomes after ballet injury were those who were older, had chronicity associated with their injuries, were fearful of re-injury, or did not complete physical therapy [14,61].

As stated above, 75% of re-injuries affect a different body part, highlighting the role of regional interdependence. The term "regional interdependence" refers to the interaction between body regions and how dysfunction in one location can contribute to dysfunction in other areas. Regional interdependence and the neurological component of a musculoskeletal injury can assist in explaining why injuries at one site can increase the risk of sustaining another injury in a different body part [14,61,32]. It has long been settled in general sports medicine literature that a previous ankle sprain is a risk factor for re-injury to the ipsilateral and to the contralateral ankle [48]. It is also well known that years after the initial injury, and regardless of surgical intervention, anterior cruciate ligament (ACL) ruptures can result in significantly reduced maximal voluntary activation of the quadriceps. Further, one-third of hamstring injuries recur within the first two weeks of returning to sport as impaired activation (neuromuscular inhibition) and atrophy of the injured muscle often persist after pain has resolved [13,22,24,60]. The rate of re-injury increases when standard therapy fails to address reflexive stability deficits on the uninjured side [5,11,12,22,61]. While no single ballet rehabilitation strategy can be regarded as the gold standard, it is far too common for the ballet dancer’s health care team to prioritize strength, power, and flexibility in the injured body region while ignoring global biomechanics and neuromuscular control [14,61,62].

In ballet, prevention of injury and re-injury is highly dependent on proper scapular kinetics, pelvic and lumbar position, breath control, and the ability to control the extremities around a stable spine [56,62]. Functionally based therapies often use kinesio tape to assist the ballet dancer in optimizing proprioception and stability [36,38,63]. Pain has been reported to increase re-injury risk by altering central nervous system signaling. The altered signal then interferes with both muscle recruitment and lengthening of the musculotendinous unit which results in re-injury. As training while in pain increases the likelihood of re-injury, pain control is therefore an important factor to be considered while managing injuries [30-32,53].

Although many ballet dancers unnecessarily fear "bulking up", resistance training programs improve performance and are thought to reduce the risk of re-injury [50]. In addition, it is generally accepted that cardiovascular fitness prevents re-injury as fatigue has been shown to adversely affect a dancer's capacity to sustain the neuromuscular control necessary for functionally stable movement [24,64]. While one study concluded that supplemental cardiovascular training to dance did not reduce injury risk, this systematic review was limited by a small sample size, lower-level studies, short duration of supplemental training (eight weeks), and a lack of dance-specific endpoints [43].

Completion of basic rehabilitation

During basic rehabilitation (parallels the recovery phase of rehabilitation), it is essential to address proper jumping and landing mechanics while maintaining conditioning of the non-injured areas. For example, it has been documented that the average ballet dancer may jump up to 200 times in a 90-minute class, demonstrating the importance of proper movement retraining [41,65]. One may observe a ballet dancer performing, what appear to be, high-level activities, such as grande allegro; however, a focused analysis may reveal a lack of controlled movement. Although it may seem that the dancer is correctly executing an expansive jump, the dancer may be using momentum to simply "throw" the limb into the end portion of the range of motion. This can demonstrate a lack of full motor control and a failure to address this inadequacy during injury rehabilitation will likely result in re-injury. Rehabilitation must not only focus on dance fitness but also on identifying and correcting underlying dysfunctional movement patterns [5-7,9,51].

Despite the importance of neuromuscular proprioceptive exercises in most of the general sports literature, Postle’s systematic review of ankle injuries found that with the addition of ankle proprioceptive exercises, there was not a statistically significant difference in the occurrence of recurrent ankle injury [61]. Postle’s systematic review, however, did conclude that neuromuscular rehabilitation improved function and reduced subjective feelings of instability [61].

As stated previously, it has been established in the general sports medicine literature that athletes have a 30% risk of re-injury after returning from injury. One potential explanation for the increased risk of re-injury is the lack of available evidence-based testing for “biologic readiness” of tissue healing, defined as when tissue has returned to its pre-injury tensile strength. Without such a tool, it is imperative that a dance medicine practitioner incorporate a timely, effective RTS protocol upon assessing the movement patterns [6,51].
Because ballet has many unique movements not seen in other sports, it is our opinion that an injured ballet dancer would benefit from an in-person individual assessment from a licensed medical provider with dance experience. A dance medicine professional considers what exercises are possible to continue during recovery from injury, and can assist in providing an individualized plan. In the acute rehabilitation phase, for example, the ballet dancer can often perform dance skill visualization exercises and a non-weight bearing ballet barre series performed lying on the floor or floating in a swimming pool. During the recovery phase, the dance medicine specialist can assist in advancing a medical plan with the goal of maintaining strength and neuromuscular control with relative rest and protection of the injured body part [22,24,61]. Finally, the dance medicine clinician can assist in determining when the ballet dancer is ready for the final phase of rehabilitation, the functional phase, and assist in safely progressing an athlete through this late rehabilitation RTS phase. Our protocol can be of assistance in this endeavor. Unfortunately, a large proportion of general clinicians advise a period of complete rest after an injury and then expect the ballet dancer to be able to RTS with the instructions to “take it easy at first”. Our experience has shown that providing a structured, progressive ballet-specific RTS rehabilitation protocol is a more effective approach to preventing re-injury.

**When to begin return to ballet protocol: seven objective criteria for readiness**

Our review resulted in the development of seven evidence-based criteria to signify the end of basic rehabilitation and the dancer’s readiness to begin the RTS protocol. These recommendations are intended to serve only as a guide and require that the licensed medical clinician critically evaluate if the athlete is ready to safely begin our “Return to Ballet Protocol” based on injury type and variation in healing.

One: Goals of basic cardiovascular fitness should be demonstrated by a validated method. One such test is the “accelerated 3-minute step test” which measures heart rate recovery after three minutes of stepping on and off a 12-inch-high step to a 112 beats per minute metronome tempo [17,66].

Two: The dancer should demonstrate proper diaphragmatic breath and rib control, control of the transversus abdominus, deep hip external rotators, and foot intrinsicis with speed, intensity, and surface instability [14,17,26,38,56].

Three: The dancer should be able to perform a single leg stance for at least 30 seconds [24,44,48].

Four: Motor strength at the hip and knee should demonstrate muscular control through the entire range of their mobility, rather than just relying on momentum to achieve the end range of motion [26,67,68].

Five: Neuromuscular deficits and ballet technique errors should be corrected with a reeducation of dysfunctional movement [22-24,38,61]. This would include the recovery of balance, coordination, and agility with motor control in all planes of movement [6,48].

Six: The ballet dancer should exhibit a pain-free range of motion and near-equal muscle strength (within 80-90%) when comparing the affected extremity to the unaffected extremity [6,8,9,58]. Symmetrical strength has been shown to be more important than maximum strength when returning to all sports, including ballet [5,18].

Seven: As recovery progression and retention of movement patterns are affected by sleep, stress, and nutrition, these factors should also be addressed and corrected prior to starting our “Return to Ballet Protocol” [5,6,10,18,36,69].

**Individualizing progression through the return to ballet protocol**

If the injured ballet dancer meets the above criteria, they can begin the functional RTS phase with our “Return to Ballet Protocol” (Table 1). Treatment timeframes progressing through the protocol’s stepwise stages may vary and may require adjustment by the medical practitioner based on rates of healing, body part affected, and injury type [10].

Athletes often experience some degree of discomfort in returning to sport and have a difficult time determining when to push through the discomfort or when to stop. As the clinician guides the dancer through the RTS protocol, we advise that the dancer use a modified version of Pearce’s “soreness rules” (Table 4) [9].
| Criterion                                                                 | Action                                      |
|--------------------------------------------------------------------------|---------------------------------------------|
| Soreness during warm-up that continues during practice                   | Take 2 days off and drop back to previous stage |
| 2-3/10 soreness during warm-up that resolves                             | Advance as per protocol recommendations     |
| Soreness during warm-up that initially resolves but recurs during practice| Take 2 days off and drop back to previous stage |
| Soreness that starts the next day and does not resolve in 24 hours        | Take 1 day off and resume stage              |

TABLE 4: Modified Pearce's Soreness Rules*

*Soreness is defined as discomfort greater than 3/10.[9]

While progressing through our protocol (Table 1), the dancer’s discomfort should ideally remain a three or below on a scale of 10 when returning to ballet movements [9,46]. Any discomfort should improve with warm-up, and any flare-up of discomfort should subside within 24 hours of the onset [9,10]. When soreness persists, the path through the modified Pearce soreness protocol is recommended [9]. If despite these instructions, the ballet dancer has difficulty progressing to the next phase because of persistent or increasing pain, referral back to a licensed medical clinician should be considered [9,10].

A common initial recommendation for overuse injuries would be for the ballet dancer to remain at each stage for three to five practice days and begin the protocol at 50% of their normal practice volume before attempting to advance to the next stage. Before advancing to stage 2, the athlete should have progressed to 100% of practice intensity for stage 1 (Table 1) [8,10].

It is also important to consider the allowed hours of training as the ballet dancer returns to practice [29]. Depending on the nature and extent of the injury, training hours may need to be limited for several weeks, to even months in some cases.

In the event of multiple trauma, the licensed dance medicine clinician should select a body region-specific protocol based on the most painful injury and progress based on symptoms.

A slower ramp-up time frame is often required for impact-related injuries such as fractures, osteochondral defects, or surgical recovery. For impact injuries, the authors commonly recommend keeping the dancer at each stage of our delineated RTS protocol, as set forth in Table 1, for at least seven practice days and starting at 25% of the normal practice volume before attempting to progress to the next stage. Initially, the ballet dancer should be able to rest between exercises and advance as tolerated. A slower ramp-up will also be required when the dancer has multiple concomitant injuries [8,10]. The ramp-up progression rate for overuse injuries and muscular strains often progresses more quickly.

As the ballet dancer builds strength and dance endurance, less rest between exercises will be required and the hours of practice time will increase. Limiting the number of repetitions of difficult skills to 5-10 per practice is often initially helpful. Learning new skills should not be attempted until the ballet dancer has progressed through the entire protocol [5,6,8,10].

Limitations

One potential drawback of our review is that we found no evidence-based RTS literature on exactly when a ballet dancer would be ready to RTS. Therefore, the objective readiness criteria to initiate an RTS protocol were extrapolated from studies involving other sports: primarily male, college-aged, soccer and American football players. Further, our search revealed no evidence-based, ballet-specific, body region-specific protocols for the functional RTS phase of late rehabilitation. The generalizability of RTS protocols to ballet was often hindered by heterogeneous, small study populations that included sports other than dance. Therefore, we created our protocol based on our clinical experience as well as review of general expert opinion pieces primarily based on other sports. The protocol was developed with an isolated injury in mind. As stated previously, the provider should prioritize the most painful injury when treating a ballet dancer with multiple trauma.

Finally, the limitations of our review of ballet injuries and re-injuries were hindered by the lack of a uniform definition of injury among studies, and heterogenous methodologies in data collection and reporting of injury and re-injury. For instance, some studies defined injuries as any event requiring time away from ballet, but this definition may miss a significant portion of injuries as many ballet dancers continue to perform despite pain.
Conclusions

The dual purpose of this review was to conduct a comprehensive literature search to identify factors that impact injury, re-injury, and recovery for common ballet injuries, and to provide clinicians with timing guidelines for entering and implementing our novel ballet-and-body region-specific late-stage rehabilitation (functional phase) RTS protocol. Thus far, clinicians have to rely on low-level evidence including informal, incomplete, and heterogeneous expert opinions when recommending when to start and how to progress late-stage RTS rehabilitation protocols. The current body of research regarding RTS in ballet is sparse, replete with bias, and RTS readiness criteria are reported inconsistently and heterogeneously. There is a lack of clear, standardized criteria in the dance science literature to assist medical providers in guiding injured ballet dancers’ safely back to ballet after an injury, especially during the vulnerable phase of tissue healing where pain has resolved but tissue maturation is not yet complete. As ballet has unique movement patterns not seen in any other sports, a consensus in the literature is needed regarding the precise dance moves, balance, and strength requirements required preceding a safe RTS in ballet.

Further research is also needed to fill the existing gaps in the ballet literature to provide clinicians with evidence-based RTS guidance. Our hope is that our “Return to Ballet Protocol” will not only prevent re-injury by directing the ballet dancer safely back into full participation but will also inspire future research by clinicians to standardize ballet-specific RTS decisions. Controlled clinical trials using consistent terminology that compare validated functional performance measures against conventional protocols are needed.

Additional Information

Disclosures

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

We would be remiss if we failed to express sincere appreciation to Ms. Darlene Robertelli and Ms. Lawren Wilkins of the Booker Health Sciences Library at Jersey Shore Medical Center. Their efforts in procuring the full text articles for our review are truly appreciated. We are also sincerely grateful to Ms. Kathy Pearbell, Ms. Eileen Gunn, Ms. Ramona Cachinero, Ms. Pamela Critelli and Ms. Brittany Cohen. These ballet dancers, dance teachers, and dance professionals generously devoted their time and shared invaluable knowledge gleaned from their many years of experience. We are truly appreciative of the advice of Stephen Glasser, M.D., for his guidance in proofreading the manuscript and invaluable insight in developing the search strategy.

References

1. Vosseller JT, Dennis ER, Bronner S: Ankle injuries in dancers. J Am Acad Orthop Surg. 2019, 27:582-589. 10.543/UADCOS-D-18-00598
2. Dhillon H, Dhillon S, Dhillon MS: Current concepts in sports injury rehabilitation. Indian J Orthop. 2017, 51:529-536. 10.4103/ortho.IJOrtho_226_17
3. Carreño L, Thomasma E, Mason J, Pitt W, Crowell M: Comprehensive rehabilitation of the athlete: a specific and purposeful approach. Sports Med Arthrosc Rev. 2021, 29:57-64. 10.1097/JSA.0000000000000333
4. English B: Phases of rehabilitation. Foot Ankle Clin. 2013, 18:357-367. 10.1016/j.facl.2013.02.011
5. Buckthorpe M: Recommendations for movement re-training after ACL reconstruction. Sports Med. 2021, 51:1601-1618. 10.1007/s40279-021-01454-5
6. Buckthorpe M: Optimising the late-stage rehabilitation and return-to-sport training and testing process after ACL reconstruction. Sports Med. 2019, 49:1043-1058. 10.1007/s40279-019-01102-z
7. Buckthorpe M, Roi GS: The time has come to incorporate a greater focus on rate of force development training in the sports injury rehabilitation process. Muscles Ligaments Tendons J. 2017, 7:435-441. 10.11138/mltj/2017.7.3.435
8. Fournier M: Principles of rehabilitation and return to sports following injury. Clin Podiatr Med Surg. 2015, 32:261-268. 10.1016/j.cpm.2014.11.009
9. Pearce CJ, Tourné Y, Zellers J, Terrier R, Toschi P, Silbernagel KG: Rehabilitation after anatomical ankle ligament repair or reconstruction. Knee Surg Sports Traumatol Arthrosc. 2016, 24:1130-1139. 10.1007/s00167-016-4051-z
10. Sweeney EA, Howell DR, James DA, Potter MN, Provance AJ: Returning to sport after gymnastics injuries. Curr Sports Med Rep. 2018, 17:376-380. 10.1249/JSR.0000000000000533
11. Cook G, Burton L, Hoogenboom BJ, Voight M: Functional movement screening: the use of fundamental movements as an assessment of function - part 1. Int J Sports Phys Ther. 2014, 9:396-409.
12. Cook G, Burton L, Hoogenboom BJ, Voight M: Functional movement screening: the use of fundamental movements as an assessment of function-part 2. Int J Sports Phys Ther. 2014, 9:549-563.
13. Ishai L, Krommes K, Husted RS, Juhl CB, Thorborg K: Diagnosis, prevention and treatment of common lower extremity muscle injuries in sport - grading the evidence: a statement paper commissioned by the Danish...
Angioi M, Hodgson K, Okholm Kryger K: Time training or professional level dance: a systematic review and meta-analysis. Phys Ther Sport. 2020, 44:14-23. 10.1016/j.ptsp.2020.03.010

Fuller M, Moyle GM, Hunt AP, Minett GM: Injury occurrence and return to dance in professional ballet: prospective analysis of specific correlates. Int J Environ Res Public Health. 2019, 16:765. 10.3390/ijerph16050765

Leanderson G, Leanderson J, Wykman A, Strander LE, Johansson SE: Sundquist K: Musculoskeletal injuries in young ballet dancers. Knee Surg Sports Traumatol Arthrosc. 2011, 19:1531-1535. 10.1007/s00167-011-1445-9

Ekegren CL, Quested R, Brodrick A: Injuries in pre-professional ballet dancers: incidence, characteristics and consequences. J Sci Med Sport. 2014, 17:271-275. 10.1016/j.jsams.2013.07.013

Jeffries AC, Wallace L, Coutu AJ, Cohen AM, McCall A, Impellizzeri FM: Injury, illness, and training load in a professional contemporary dance company: a prospective study. J Athl Train. 2020, 55:967-976. 10.4085/1062-6050-477-19

Fuller M, Moyle GM, Hunt AP, Minett GM: Injuries during transition periods across the year in pre-professional and professional ballet and contemporary dancers: a systematic review and meta-analysis. Phys Ther Sport. 2020, 44:14-23. 10.1016/j.ptsp.2020.03.010

Fuller M, Moyle GM, Hunt AP, Minett GM: Ballet and contemporary dance injuries when transitioning to full-time training or professional level dance: a systematic review. J Dance Med Sci. 2019, 23:112-125. 10.12678/1089-313X.20.1.30

Fuller M, Moyle GM, Minett GM: Injuries across a pre-professional ballet and contemporary dance tertiary training program: a retrospective cohort study. J Sci Med Sport. 2020, 23:1166-1171. 10.1016/j.jsams.2020.06.012

Anand Prakash A: Medical attention seeking dance injuries: systematic review of case reports. Phys Sportsmed. 2017, 45:64-74. 10.1080/00913847.2017.1270700

Campoy FA, Coelho LR, Bastos FN, et al.: Investigation of risk factors and characteristics of dance injuries. Clin J Sport Med. 2011, 21:493-498. 10.1249/MSS.0b013e3182030858

Kaufmann JE, Nelissen RG, Appleton PR, Gaderman MG: Perceptions of motivational climate and association with musculoskeletal injuries in ballet dancers. Med Probl Perform Art. 2021, 36:187-198. 10.21091/mppa.2021.3021

Jacobs CL, Hincapié CA, Cassidy JD: Musculoskeletal injuries and pain in dancers: a systematic review update. J Dance Med Sci. 2012, 16:74-84.

Allen N, Nevill A, Brooks J, Koutedakies Y, Wyon M: Ballet injuries: injury incidence and severity over 1 year. J Orthop Phys Sports Phys Ther. 2012, 42:781-790. 10.2519/jopst.2012.3893

Smith TO, Davies L, de Medici A, Hakim A, Haddad F, Macgregor A: Prevalence and profile of musculoskeletal injuries in ballet dancers: a systematic review and meta-analysis. Phys Ther. 2016, 19:50-56. 10.1016/j.physio.2015.12.007

Allen N, Nevill AM, Brooks JH, Koutedakies Y, Wyon MA: The effect of a comprehensive injury audit program on injury incidence in ballet: a 3-year prospective study. Clin J Sport Med. 2013, 23:373-378. 10.1097/JSM.0b013e3182877576

Thomson P, Jaque SV: Cumulative psychological trauma, emotional regulation, and orthopedic injury in a sample of pre-professional and professional dancers and college athletes. Med Probl Perform Art. 2020, 35:89-95. 10.21091/mppa.2020.2014

Molina JP, Nunes A, Estevé J, Oliveira R, Xarez L: The relationship between muscular strength and dance injuries: a systematic review. Med Probl Perform Art. 2017, 32:40-50. 10.21091/mppa.2017.1002

Angioi M, Hodgson K, O’Kholm Kryger K: An updated systematic review of turn-out position assessment for dancers.
protocols used in dance medicine and science research. J Dance Med Sci. 2021, 25:55-71. 10.12678/1089-313X.031521.

43. Ambegaokar JP, Chong L, Joshi P: Supplemental training in dance: a systematic review. Phys Med Rehabil Clin N Am. 2021, 32:117-135. 10.1016/j.pmr.2020.09.006

44. Vera AM, Barrera BD, Peterson LE, et al.: An injury prevention program for professional ballet: a randomized controlled investigation. Orthop J Sports Med. 2020, 8:2325967120937643. 10.1177/2325967120937643

45. Ankem HK, Yelton MJ, Lall AC, et al.: Structured physical therapy protocols following hip arthroscopy and their effect on patient-reported outcomes of a systematic review of the literature. J Hip Presv Surg. 2020, 7:235-337. 10.1093/jhs/hnaa042

46. Hickey JT, Timmins RG, Maniar N, Williams MD, Opar DA: Criteria for progressing rehabilitation and determining return-to-play clearance following hamstring strain injury: a systematic review. Sports Med. 2017, 47:1375-1387. 10.1007/s40279-016-0667-x

47. Powell C, Jensen J, Johnson S: Functional performance measures used for return-to-sport criteria in youth following lower-extremity injury. J Sport Rehabil. 2018, 27:581-590. 10.1123/jsr.2017-0061

48. Wilkström EA, Mueller C, Cain MS: Lack of consensus on return-to-sport criteria following lateral ankle sprain: a systematic review of expert opinions. J Sport Rehabil. 2020, 29:231-237. 10.1123/jsr.2019-0038

49. O’Connor M, Minkara AA, Westermann RW, Rosneck J, Lynch TS: Return to play after hip arthroscopy: a systematic review and meta-analysis. Am J Sports Med. 2018, 46:2780-2788. 10.1177/0363546518795731

50. Junck E, Richardson M, Dilgen F, Liederbach M: A retrospective assessment of return to function in dance after physical therapy for common dance injuries. J Dance Med Sci. 2017, 21:156-167. 10.12678/1089-313X.21.4.156

51. van der Horst N, van de Hoef S, Reurink G, Huisstede B, Backx F: Return to play after hamstring injuries: a qualitative systematic review of definitions and criteria. Sports Med. 2016, 46:899-912. 10.1007/s40279-015-0468-7

52. Bowerman E, Whiteman C, Harris N, Bradshaw E, Karin J: Are maturation, growth and lower extremity alignment associated with overuse injury in elite adolescent ballet dancers? Phys Ther Sport. 2014, 15:234-241. 10.1016/j.ptsp.2013.12.014

53. Pappas E, Onishiho KF, Kremenic I, Liederbach M, Hagins M: The effects of floor incline on lower extremity biomechanics during unilateral landing from a jump in dancers. J Appl Biomech. 2012, 28:192-199. 10.1123/jab.28.2.192

54. Mattiussi AM, Shaw JW, Williams S, et al.: Injury epidemiology in professional ballet: a five-season prospective study of 1596 medical attention injuries and 543 time-loss injuries. Br J Sports Med. 2021, 55:843-850. 10.1136/bjsports-2020-103817

55. van Setser C, van Rijn RM, van Middelkoop M, Stubbe JH: Risk factors for lower-extremity injuries among contemporary dance students. Clin J Sport Med. 2020, 30:60-66. 10.1097/JSM.0000000000000533

56. Biernacki JL, Stracciolini A, Fraser J, Micheli L, Sugimoto D: Risk factors for lower-extremity injuries in female ballet dancers: a systematic review. Clin J Sport Med. 2021, 31:64-79. 10.1097/JSM.0000000000000707

57. Sanches SB, Oliveira GM, Osório FL, Crippa JA, Martin-Santos R: Hypermobility and joint hypermobility syndrome in Brazilian students and teachers of ballet dance. Rheumatol Int. 2015, 35:741-747. 10.1007/s00296-014-3127-7

58. Palmieri-Smith RM, Lepley JK: Quadriceps strength asymmetry after anterior cruciate ligament reconstruction alters knee joint biomechanics and functional performance at time of return to activity. Am J Sports Med. 2015, 43:1662-1669. 10.1177/0363546515578252

59. Grindem H, Snyder-Mackler L, Moksnes H, Engebretsen L, Risberg MA: Simple decision rules can reduce reinjury risk by 84% after ACL reconstruction: the Delaware-Oslo ACL cohort study. Br J Sports Med. 2016, 50:804-808. 10.1136/bjsports-2016-096031

60. van Melick N, van Cingel RE, Brooijmans F, Neeter C, van Tienen T, Hullegie W, Nijhuis-van der Sanden MW: Evidence-based clinical practice update: practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus. Br J Sports Med. 2016, 50:1506-1515. 10.1136/bjsports-2015-095989

61. Postle K, Pak D, Smith TO: Effectiveness of proprioceptive exercises for ankle ligament injury in adults: a systematic literature and meta-analysis. Man Ther. 2012, 17:285-291. 10.1016/j.math.2012.02.016

62. Ulman S, Erdman A, Loewen A, et al.: Concurrent validity of movement screening criteria designed to identify injury risk factors in adolescent female volleyball players. Front Sports Act Living. 2022, 4:915230. 10.3389/fspor.2022.915230

63. Reneker JC, Latham L, McGlawn R, Reneker MR: Effectiveness of kinesiology tape on sports performance abilities in athletes: a systematic review. Phys Ther Sport. 2018, 31:83-98. 10.1016/j.ptsp.2017.10.001

64. Nagelli CV, Di Stasi S, Wordeman SC, Chen A, Tatarski R, Hoffman J, Hewett TE: Knee biomechanical deficits during a single-leg landing task are addressed with neuromuscular training in anterior cruciate ligament-reconstructed athletes. Clin J Sport Med. 2021, 31:347-353. 10.1097/JSM.0000000000000792

65. Hanwood A, Campbell A, Hendry D, Ng L, Wild CY: Differences in lower limb biomechanics between ballet dancers and non-dancers during functional landing tasks. Phys Ther Sport. 2018, 32:180-186. 10.1016/j.ptsp.2018.05.005

66. Bronner S, Rakov S: An accelerated step test to assess dancer pre-season aerobic fitness. J Dance Med Sci. 2014, 18:12-21. 10.12678/1089-313X.18.1.12

67. Trentacosta N, Sugimoto D, Micheli LJ: Hip and groin injuries in dancers: a systematic review. Sports Health. 2017, 9:422-427. 10.1177/1941738117724159

68. Rodriguez M, Bolaik MK, Phillips MD, Briggs KK, Phillips MJ: Hip screening of a professional ballet company using ultrasound-assisted physical examination diagnosing the at-risk hip. J Dance Med Sci. 2019, 23:51-57. 10.12678/1089-313X.23.2.51

69. Nwachukwu BU, Adjei J, Rauck RC, et al.: How much do psychological factors affect lack of return to play after anterior cruciate ligament reconstruction? A systematic review. Orthop J Sports Med. 2019, 7:2325967119845313. 10.1093/ptsr/ptsaa042