Returning to Sport: A Level-Based Guide for Women's Artistic Developmental Program Gymnasts

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Female artistic gymnasts, defined as gymnasts who compete in the vault, uneven parallel bars, balance beam, and floor events, may be affected by a wide variety of acute and overuse injuries throughout their athletic careers. Returning these athletes to their sport safely after an injury requires detailed knowledge of the various events in which they compete as well as a familiarity with what is expected of these gymnasts at the various levels of training and competition. Despite the complexity described above, there are few published resources to help providers guide the female artistic gymnast back to sport after injury. Therefore, we developed two purposes for this paper: (1) to review important concepts regarding return to play (RTP) in women's artistic gymnastics and (2) to add to the existing literature on RTP in women's gymnastics by providing RTP protocols that consider a gymnast's training level as well as injured body area.

INTRODUCTION

The sport of gymnastics can be dated back to the ancient Olympic games, when it was added to the competitive roster by the Athenians in 700 BC.[1] As a form of exercise, broadly-defined forms of gymnastics continued to be practiced at some level throughout ancient, medieval, and renaissance times.[2] With the inclusion of men's gymnastics in the modern Olympics in 1896, the Olympic debut of women's gymnastics in 1926, and the eventual television broadcasting of the Olympic games, gymnastics soared in popularity.[1-4] There are now over 4 million gymnastics participants over the age of 6 years old across the United States, with over 90,000 athletes participating in competitive gymnastics through the USA Gymnastics (USAG) organization.[5-7] Women's gymnastics in particular is a popular competition sport among athletes within the USAG system.[8] Competitive gymnastics has been divided into the categories of artistic gymnastics, rhythmic gymnastics, acrobatic gymnastics, trampoline and tumbling, and gymnastics for all.[4] Within women's artistic gymnastics in USAG, there are two programs, Junior Olympic (now called Development Program) and Xcel. Gymnasts can choose to compete in either program. The Development Program consists of progressively difficult levels and typically is more competitive, requiring more hours in the gym, than the Xcel Program. The Development Program uses numbers (i.e., Levels 1-10) to denote competitive level, while the more recently established Xcel system uses the colors bronze, silver, gold, platinum, and diamond. The Xcel program continues to grow and may soon incorporate a Sapphire level, which would be similar to levels 7-10 in the Development Program.

Injury Epidemiology

Artistic gymnasts have a high injury rate both in practice and competition.[8] One recent analysis of severe injuries (defined as injuries occurring during sanctioned practice or competition which required medical attention and resulted in at least 21 days of sport lost) among collegiate athletes from the 2009-2010 to the 2014-2015 academic year found that women's gymnastics was second only to wrestling in its rate of severe injuries.[9] Another analysis of college sport-related injuries in the United States between the 2009-2010 and 2013-2014 seasons found that of all women's sports, gymnastics had the highest overall rate of injury as well as the highest rate of practice-related injury.[10]

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College-level as well as club-level artistic female gymnasts demonstrate highest acute injury rates during the floor event, wherein the gymnast performs a choreographed routine on a spring floor (Table 1).[3,11–13] One study by O'Kane et al. specifically investigating injury rates among club-level female artistic gymnasts in Seattle found that 32.1% of acute injuries occurred during the floor event, while another study also looking at club-level artistic gymnasts similarly found that 40% of acute injuries occurred during floor.[11,12] At all levels, female artistic gymnasts are noted to have high incidences of overuse injuries such as stress fractures, which female gymnasts are known to suffer from at higher rates than other athletes.[14]

Unlike many other types of athletes, the gymnast's entire body is regularly at risk for injury due to strength, flexibility, and body control requirements of the sport.[4,15] However, lower extremity injuries are consistently found to be most prevalent in women's gymnastics.[3,11,13,16] Highest rates of reported injury involved the knee (13.1%), ankle (12.6%), and foot (12.1%).[17] Studies looking specifically at injury rates among club-level (or, in other countries, pre-national) female gymnasts found the foot and ankle to be at highest risk, followed closely by the knee.[11,13]

Despite the popularity of gymnastics and the high injury rates that occur in the sport, there is sparse published guidance on how to return these athletes safely to gymnastics once recovered. The purposes of this paper are (1) to review important concepts regarding return to play (RTP) in women's artistic gymnastics and (2) to add to the existing literature on RTP in women's gymnastics by providing RTP protocols that consider a gymnast's training level as well as injured body area.

RETURN TO PLAY CONSIDERATIONS FOR WOMEN'S ARTISTIC GYMNASTICS

General Principles

In sports medicine, RTP guidelines provide step-wise, progressive pathways that help athletes who have recovered from an injury to reintegrate into their sport safely by minimizing the risk of reinjury or secondary injury.[18] This mitigation of risk, however, must also be balanced by the responsibility of the medical team to help athletes return to their pre-injury activity level as soon as they safely can. This is an especially important consideration as the injured athlete may be more vulnerable to depression or anxiety while out of sport.[18] Generally, medical staff should consider the following criteria when deciding to start any athlete on a RTP protocol: resolution of pain, demonstration of full joint range of motion (ROM) and strength, completion of physical therapy or other injury rehabilitation, and psychological readiness to return to sport.[19]

Elements of psychological readiness that should be considered when returning an athlete to sport include low fear, confidence, and motivation.[20,21] One systematic review found that positive responses to evaluation of these three factors was associated with a greater likelihood of RTP at a preinjury level.[20] Another systematic review, specifically investigating psychological elements affecting RTP after anterior cruciate ligament reconstruction (ACLR), found that fear was the most common psychological reason reported by athletes for failing to achieve RTP, followed by lack of confidence, depression, and lack of interest/motivation.[21]

The speed at which athletes return to sport once they are cleared to begin the protocol must, like most other aspects of sports medicine, be individualized. To allow appropriate time for healing and to regain proper form, gymnasts should not complete more than one step of the RTP protocol daily. Some athletes may need to remain at a particular step for several days in the setting of more severe injury, longer time away from sport, or changes in psychological readiness as skills become increasingly difficult.[15] Importantly, athletes should be instructed not to continue progressing through the RTP protocol with pain or poor form. If an athlete experiences pain while practicing a skill or step, she should be instructed to take a rest day before returning to the last asymptomatic step. Inability to progress through the protocol due to recurrent pain should prompt a follow up with the athlete's medical team.[15]

In addition to factors such as time away from sport and baseline training level, it is important to consider the variability of tissue adaptation timelines when determining the speed at which an athlete returns to sport. For example, skeletal muscle can take between 24 to 48 hours to adapt to exercise stress whereas tendon and tendon-related connective tissue may take up to 72 hours to adapt to increased mechanical loading.[22,23] One way to gradually progress the tissue impact experienced by artistic gymnasts while they are returning to sport is to alter their landing equipment (Table 1). For example, for the floor event, the gymnast should first practice a new skill on tumble track (a

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long trampoline), before progressing to rod floor, before progressing to floor mats of decreasing thickness.[15]

When making an RTP plan for a recovering gymnast, a provider must take into account, in addition to the above considerations, that female artistic gymnasts are essentially competing in four different sports: the vault, uneven bars, balance beam, and floor (Table 1). Each of these events comprises different strength, flexibility, and proprioceptive demands.[4,15] Additionally, the equipment available at different gymnastics facilities may vary greatly, which should be taken into consideration when counseling on RTP. For example, the timeline for a recovering gymnast to return to impact activities may depend on whether she has access to trampolines and rod strips before transferring her skills to a hard floor. RTP for the female gymnast becomes even more complex when one takes into consideration the different levels at which gymnasts compete, with beginner level and advanced level gymnastics being significantly different in terms of skills performed and hours of practice required.

For the purposes of this paper and to create more widely applicable protocols, we have used the Development Program levels to create specific RTP guidelines.

- **Levels 1-3**: These are often considered pre-competition levels. While gymnasts may compete at this level, it is not required to compete in these levels in order to advance to the next level.
- **Levels 4-5**: These are the first competition levels which require that gymnasts compete in order to advance to the next level. These levels are also unique in that they are compulsory levels, meaning all female gymnasts complete the same routine in each event to demonstrate competency in their skills. For the purposes of this paper, we use Levels 5 and below as the first RTP protocol for all gymnastics injuries.
- **Level 6**: While there are still level-specific skill requirements for level 6, gymnasts perform unique routines but have limitations on more difficult skills that they may perform.
- **Level 7-10**: Progressively difficult skills are allowed in these levels. Gymnasts have more options regarding the skills they may perform.

Women's Gymnastics: Description of Terms (Table 1)

Vault

During vault, the gymnast sprints toward a springboard, propelling herself onto the vault, and launching off the vault with a flip or twist onto a landing surface of mats. Important variations of this skill required at different levels include the Tsukahara, or Tsuk, (round-off entry onto the vault from the springboard), and Yurchenko entry (round-off onto the springboard, followed by back handspring entry onto vault).

Uneven Parallel Bars

In the uneven parallel bars, the gymnast performs a continuous series of movements, including circling elements, pirouettes, releases from one bar to another, and ending with a dismount off the bars. These movement series may include specific skills such as kips (pushing down from under the bar in order to lift the body to a front support), casts (moving from front support to a handstand position), giants (backwards or forwards swings around the bar in a continuous handstand position), and pirouettes (twisting the body on a base arm holding the bar). Release moves typically refer to a series of movements in which the gymnast lets go of the bar, performs a specific movement in the air such as a flip or twist, and recatches the bar.

Balance Beam

Gymnasts perform a choreographed routine which includes elements of tumbling, leaping, and dancing followed by a dismount from the beam. The beam is 4in wide (10cm) and 16.4ft (5m) long, covered with a layer of suede. In addition to many of the movements described above, the gymnast may also perform switch leaps (where she switches her leading leg while in the air), turns on one foot, handsprings, and flipping skills.

Floor Event

For the floor exercise, the gymnast performs a continuous choreographed routine which includes elements of tumbling, leaps, and dancing. These routines are performed on a spring floor and are choreographed to music. Commonly performed skills include a round-off (a forward tumbling movement where the gymnast uses both her hands to propel herself forward and finishes with a half turn, landing facing the opposite direction from which she started), front and back layouts (a flip performed with a straight body), and double backs (completing two back flips before landing).

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Table 1. Description of artistic gymnastics events related to return to play

Event	*Description*	*Notable Skills*	*Landing Surfaces*
Vault	The gymnast sprints toward a springboard, propels herself onto the vault, and launches off the vault with a flip or twist onto a landing surface of mats	Front Handspring: springing from feet onto hands and back to feet in a forward direction Tsukahara, or Tsuk: a round-off entry onto the vault from the springboard Yurchenko: a round-off onto the springboard followed by back handspring entry onto vault *Timers, for any skill, consist of the vault, without including the flip off the table*	Vaults are usually performed onto 4- or 8-inch soft landing mats. Other options for athlete returning to sport from injury include (in order of ascending impact): 1. Portable pit mat for timers 2. Foam pit 3. Eight-inch mats stacked with sting mats (lightweight landing mats)
Uneven Parallel Bars	The gymnast performs a continuous series of movements, including circling elements, pirouettes, and releases from one bar to another followed by a dismount off the bars	Kips: pushing down from under the bar to lift the body to a front support Casts: moving from front support to a handstand position Giants: backward or forward swings around the bar in a continuous handstand position Pirouettes: twisting the body on a base arm holding the bar *Releases moves typically refer to a series of movements in which the gymnast lets go of the bar, performs a specific movement in the air such as a flip or twist, and recatches the bar*	Dismounts are usually performed on 4- or 8-inch soft landing mats. Other options for athlete returning to sport from injury include (in order of ascending impact): 1. Foam pit, 2. Eight-inch mats stacked with sting mats
Balance Beam	The gymnast performs a choreographed routine that includes elements of tumbling, leaping, and dancing followed by a dismount from the beam	Switch leaps: switching the leading leg in a leap, while in the air *Other skills for this event which are notable but not discussed in this paper include turns on one foot, handsprings, and aerial and flipping skills*	Dismounts are usually performed on 8-inch soft landing mats. Other options for athlete returning to sport from injury include: 1. Eight-inch mats stacked with sting mats
Floor Exercise	The gymnast performs a continuous choreographed routine that includes elements of tumbling, leaps, and dancing. These routines are performed on a spring floor and are choreographed to music	Round-off: a forward tumbling movement where the gymnast uses both hands to propel herself forward and finishes with a half turn, landing facing the opposite direction from which she started Handspring: springing from feet onto hands and back to feet either forward or backward Front or back layout: a flip performed with a straight body Double backs: two back flips completed in the air before landing	As the athlete is regaining her skills, she should progress from tumble track, to rod strip, to floor exercise with mats, and finally to floor exercise without mats

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Practice Volume

Depending on a gymnast's level, she may train between 9 and 40 hours per week.[19,24] The average precollegiate female artistic gymnast trains intensely, commonly practicing 20 or more hours per week.[16] Therefore, when guiding a gymnast on her RTP protocol, a provider should also emphasize the importance of progressively increasing the hours spent training, not merely the difficulty of the skills.

Existing Literature

Published interval sports programs (ISP) or RTP protocols for non-gymnastics athletes have been available for many years and may act as a theoretical basis for a gymnastics RTP plan. For example, Reinhold et al. published RTP protocols for baseball, tennis, and golf athletes which incorporate many fundamental principles of rehabilitation that should be applied to gymnastics RTP.[25] Additionally, multi-phase RTP protocols for athletes returning from ACLR have been published for women's soccer, women's field hockey, women's indoor volleyball, and for female ballet dancers.[26-29] In 2014, May et al. published return to gymnastics guidelines for athletes recovering from concussion injury.[30] In 2018, Sweeney et al. published body part specific RTP guidelines for both men's and women's high-level artistic gymnastics. These guidelines cover recommended RTP progression after injury to the wrist, elbow, shoulder, back, and lower extremity (with separate progression for both impact-related pathology as well as stability-related pathology of the lower extremity).[15] However, there is a need for published guidelines for level-specific return to sport progressions for the Development Program.

LEVEL-BASED RETURN TO PLAY PROTOCOLS

This document provides level-specific return to sport progressions divided by body area (upper extremity, lower extremity, and back) that can be used by medical professionals, athletes, and coaches involved in gymnastics. For each body area, we briefly discuss specific pathologies as examples of RTP challenges. Although this is by no means a comprehensive list of all gymnastics injuries, the injuries selected here represent a multitude of pathology types found in competitive female artistic gymnasts and provide further RTP considerations and recommendations.

Upper Extremity

An important consideration in returning female artistic gymnasts to sport after any upper extremity injury is that, unlike most other competitive sports, gymnasts use their wrists, elbows, and shoulders as dynamic and static weight-bearing joints.[4] In addition to often prolonged weight bearing, these joints are repeatedly exposed to high impact forces through end-range extension.[31] For these reasons, it is critical to ensure that a gymnast has full range of motion and strength through bilateral upper extremities, and not only the injured joint, prior to returning to sport (Tables 2-5).[19]

Wrist

While not as common as lower extremity injuries, upper extremity injuries do represent a notable portion of reported injuries among women's gymnastics participants.[32] Among collegiate-level gymnasts, the shoulder accounted for 8.86% of reported injuries; the arm/elbow, 4.26%; and the hand/wrist, 4.26%.[17] However, a recent retrospective analysis of injury data representing a broader population of gymnasts, including gymnasts at the precompetitive or precollegiate level, found higher percentages of elbow and wrist injuries, particularly in comparison to male gymnasts.[33]

Distal Radial Physeal Stress Syndrome, also called "gymnast's wrist" is a well-described overuse injury to the distal radial physis found primarily in gymnasts secondary to the high-impact loading forces repetitively placed through the wrist. It is typically diagnosed by a history of chronic dorsal or radial-sided wrist pain, a physical exam demonstrating pain at the distal radial physis and possibly decreased wrist mobility, and with radiographic findings of an irregular or widened distal radial physis.[34,35] Treatment typically consists of rest, often with immobilization.[34] Once a clinician deems the physeal injury to be appropriately treated, there are specific recommendations that can be made to the gymnast to reduce wrist pain and potentially avoid reinjury to the skeletally immature gymnast's wrist. One such recommendation is the use of wrist braces with volar pads.[36] Additionally, there are important biomechanical factors to address through physical therapy to prevent reinjury of the radial physis. For example, shoulder ROM upon landing back handsprings has been found to be predictive of wrist position upon impact during the same skill.[37] Therefore, ensuring appropriate shoulder flexibility

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and ROM is vital when returning an athlete to gymnastics after any wrist injury. Similarly, female gymnasts may protect their wrists through correct hand position while practicing cartwheels and roundoffs.[38–40]

Elbow

Elbow injuries in female gymnasts may be acute – such as an elbow dislocation – but are more often chronic and secondary to overuse – such as an osteochondritis dissecans (OCD) lesion or radial neck stress injury.[41–45] OCD lesions of the elbow are typically diagnosed with a history of chronic lateral elbow pain; a physical examination notable for pain to palpation of the capitellum, sometimes with abnormal elbow ROM or effusion; and either radiographic or MRI findings of an OCD.[46] Management may be non-operative or operative depending upon the stability of the lesion upon diagnosis. Radial neck stress injuries are a more recently described source of elbow pain in competitive gymnasts, but also represent an important overuse injury of the elbow. These patients often present without joint effusion and with normal elbow ROM, but still with significant lateral elbow pain. The mainstay of treatment is rest.[44,45,47,48]

Once the athlete has undergone appropriate treatment and is cleared to return to sport, it is important to consider that, like the wrist and shoulder, the elbow is exposed to extremely high impact forces in gymnastics. Additionally, the gymnast's elbow endures repetitive valgus stress resulting in compressive forces through the elbow's lateral structures as well as increased tensile forces through the medial structures. Therefore, ensuring excellent stability of the ulnar collateral ligament is critical when guiding these athletes through their RTP protocols.[43]

Table 2. Return to play after upper extremity injury (Levels 5 and below)

Step	*Vault*	*Bars*	*Beam*	*Floor*	*Tumble Track*
1		Hang on bar	Leaps, jumps, turns	Low impacts, handstands, cartwheels	Roundoffs*
2		Tap swings/glide swings**	Cartwheels, handstands	Walkovers, roundoffs	Standing back handsprings; front tumbling; Snap down stretch jumps off block on trampoline
3	Handstand hops, blocking drills	Kips, casts	Walkovers if in routine, dismounts	Standing back handsprings, front tumbling	Running back tumbling
4	Handsprings /Timer on block	Individual elements of routine	Full routines	Back tumbling connected	
5	Full vault	Full routines		Full routines	

Table 3. Return to play after upper extremity injury (Levels 6 and 7)

Step	*Vault*	*Bars*	*Beam*	*Floor*	*Tumble Track*
1		Hang on bar	Leaps, jumps, turns	Low impact, handstand, cartwheel	Roundoffs; Handstand pop/hops on trampoline
2		Tap swings/glide swings, cast to horizontal	Cartwheel, handstand, low impact	Walkovers, roundoffs,	Roundoff back handspring, front handspring; Snap down back tucks and step down front tucks off block on trampoline

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3	Handstand hops, blocking drills	Kips, cast to handstand	Walkovers if in routine, roundoffs	Roundoff back handsprings	Standing back handsprings, Saltos
4	Handsprings	Clear hips, dismounts***	Series, dismounts	Standing back handsprings, front tumbling	
5	Tsuk and Round-off entry for Yurchenko	Giants, other individual higher level skills	Full routines	Saltos, passes	
6	Full vaults	Full routines		Full routines	

Table 4. Return to play after upper extremity injury (Levels 8 and 9)

Step	*Vault*	*Bars*	*Beam*	*Floor*	*Tumble Track*
1		Hang on bar	Leaps, jumps, turns	Low impacts, handstands, cartwheels	Roundoffs
2		Tap swings/glide swings, cast to horizontal	Cartwheels, handstand, low impact	Walkovers, roundoffs,	Roundoff back handspring, front handspring; Snap down back tucks and step down front tucks off block on trampoline
3	Handstand hops, blocking drills	Kips, cast to handstand	Walkovers if in routine, roundoffs	Roundoff back handsprings	Standing back handsprings, Saltos
4	Handsprings, round off entry for Yurchenkos	Back Giants, Bar-to-bar releases with spot to stacked rest mat	Saltos, dismounts if not handspring	Standing back handsprings, front tumbling	Twisting, Salto series
5	Timers	Front Giants, Stalders, Toe-circles, and Clear Hips; Bar-to-bar releases with spot to low bar	Handsprings	Saltos	
6	Flip Vault	Pirouettes; Bar-to-bar releases alone	Flight series, dismounts with handsprings	Salto series, twisting, and double saltos	
7	Add twist if needed	Release moves; Bar-to-bar releases with connections and no spot ****	Full routines	Full routines	
8		Full routines			

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Table 5. Return to play after upper extremity injury (Level 10)

Step	*Vault*	*Bars*	*Beam*	*Floor*	*Tumble Track*
1		Hang on bar	Leaps, jumps, turns	Low impacts, handstands, cartwheels	Roundoffs
2		Tap swings/glide swings, cast to horizontal	Cartwheels, handstands, low impact	Walkovers, roundoffs,	Roundoff back handspring, front handspring; Snap down back tucks and step down front tucks off block on trampoline
3	Handstand hops, blocking drills; Roundoff whips off springboard into pit	Kips, Cast to handstand	Walkovers if in routine, roundoffs	Roundoff back handsprings	Standing back handsprings, Saltos
4	Handsprings, round off entry for Yurchenkos	Back giants, basic dismounts	Saltos, dismounts if not handspring	Standing back handsprings, front tumbling	Twisting, Salto series
5	Timers	Front Giants, Stalders, Toe-circles, Clear hips; Bar-to-bar releases with spot to stacked resi mat; Single bar release timers without releases	Handsprings	Saltos	Double Saltos
6	Flip Vault	Pirouettes; Bar-to-bar releases with spot; Single bar releases without regrasp	Flight series, Salto series, dismounts with handsprings	Salto series, twisting, Double saltos	
7	Add twist if needed	Release moves, Eagle (L-grip) giants	Full routines	Full Routines	
8		Full routines			

**We recommend progressing from tumble track, to rod strip, to floor with sing mat, to hard floor when possible.*
*** Gymnasts should use floor bar stations for shaping and kip/cast drills as an intermediary step before beginning Step 3 when possible*
****Use strap/metal bar as preparation for giants*
***** We recommend practicing blind fulls here if working toward level 10*

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Lower Extremity

Multiple studies have found that the lower extremity comprises the majority of reported injuries in female artistic gymnasts.[4,17,46] In all cases of lower extremity injuries, it is crucial to educate the gymnast on the importance of step-wise progression of weight-bearing activities before restarting high impact activities in the gym (Tables 6-9).[19]

Foot / Ankle

Foot and ankle injuries in women's artistic gymnastics range from minor sprains, strains, and contusions to more serious fractures, talar OCDs, or even surgical soft tissue injuries. Of the latter type of foot/ankle injury, Lisfranc fracture/dislocations have been described as the most commonly career-ending for elite female gymnasts.[49] For the less severe foot and ankle injuries, however, gymnasts often recover after a short course of rest, with or without immobilization, along with appropriate neuromuscular training to avoid future ankle injuries.[50] When returning a female gymnast to sport after any foot or ankle injury, athletes should initially try to use a soft landing surface such as a soft mat or foam pits.[46] If the patient is returning after a stability-related foot or ankle injury, they should also consider bracing or taping initially.[46]

Knee

Knee injuries were the most commonly reported injuries by collegiate female gymnasts.[17] These may be acute, such as a patellar dislocation or anterior cruciate ligament tear, or chronic and secondary to biomechanical disadvantage, such as patellofemoral knee pain or anterior knee impingement syndrome. One type of knee injury that can present as either acute or chronic, unilateral or bilateral, with or without effusion, is patellar instability. Of all high school sports, women's gymnastics has the highest rates of patellar instability.[51] In the absence of repetitive injuries or a concomitant osteochondral fracture, patellar instability may be treated with initial immobilization followed by thorough physical therapy and rehabilitation.[19] When returning to sport, the female gymnast may consider taping or bracing for further patellar support.

Pelvis

Although not as commonly reported as other lower extremity injuries, pelvic and hip injuries may also affect female gymnasts. For example, ischial tuberosity avulsion fractures can be a source of acute pain and disability in skeletally immature gymnasts. Female gymnasts are among the athletic groups most likely to suffer from this injury, behind soccer athletes and runners.[52,53] These injuries can be diagnosed by a history of sharp posterior thigh pain felt acutely while performing a feat that combines strength and flexibility such as a switch leap, with a physical examination demonstrating marked unilateral proximal hamstring weakness, and with radiographic evidence of an avulsed fragment(s). Treatment typically consists of rest, often remaining non-weight-bearing with crutches for a prescribed period of time, followed by significant hamstring rehabilitation.[53] In the case of this injury, the keys to successful return to play include appropriate suspicion for this often missed diagnosis and then providing an appropriate rehabilitation prescription.

Low Back / Lumbar Spine

The female gymnast's lumbar spine is susceptible to notable stresses through the forces of impact, extreme extension/flexion, and twisting.[4] Compressive forces from impact most often occur during hard landings, release moves, and dismounts.[54] Hyper-extensive forces are noted during several floor and beam skills such as tumbling passes and walkovers. Twisting forces through the spine are most notable during floor and vault events. Knowing the differences between these forces, a provider may recommend that a female artistic gymnast modify or limit one or more types of low back forces as she returns to sport (Tables 10-12).

Low back or lumbar spine injuries in gymnasts are commonly from overuse and repetitive exposure to the forces mentioned above.[55] Two such injuries are spondylolysis and spondylolisthesis.[4] Spondylolysis may be diagnosed by a history of chronic low back pain worsened by extension, decreased and painful extension on physical exam, and by radiographic or MRI findings consistent with pars interarticularis edema or fracture. The treatment for these injuries typically requires rest, physical therapy, modification of painful movements, and sometimes bracing.[56]

Although spinal injuries vary greatly, there are important considerations that apply to all female gymnasts if they are cleared to return to sport. Specifically, the patient's post injury range of motion, core stability, and plyometric power must

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be assessed and slowly progressed as they return to gymnastics.[19]

Limitations

We acknowledge several limitations to our study. First, the RTP protocols provided here are based on expert opinion and on existing gymnastics RTP literature. More prospective studies are needed to provide evidence-based timeframes and criteria for advancement between steps within the return protocols. Second, this paper does not include diagrams or figures of the skills described. We would encourage the reader to reference USAG Women's *Development Program Compulsory Book* for figures and additional details regarding the skills outlined in this study.[57]

Table 6. Return to play after lower extremity injury (Levels 5 and below)

Step	*Vault*	*Bars*	*Beam*	*Floor*	*Tumble Track*
1		Strap Bar/ Pit bar – no dismounts	Balance work, straight jumps	Turns, straight jumps	Jumps
2	Sprints Stretch jump stick off block	Dismount into Pit, swinging skills	Turns, jumps on low beam	Leaps, jumps, cartwheels, handstands, walkovers	Standing tumbling
3	Vault to land on back (drills)	Full routine-no dismount	Low beam handstands, cartwheels, walkovers Jumps on high beam	Standing tumbling	Running tumbling onto resi
4	Limited reps	Dismounts, Routines	All skills on High beam, dismounts on soft mat	Running tumbling	
5	Full Vault		Dismounts, full routines	Full Routines	

Table 7. Return to play after lower extremity injury (Levels 6 and 7)

Step	*Vault*	*Bars*	*Beam*	*Floor*	*Tumble Track*
1		Strap Bar/ Pit bar – no dismounts	Balance work, straight jumps, turns	Turns, straight jumps	Jumps
2	Sprints Snap down stretch jump stick off block	Dismount into Pit, swinging skills	Low beam handstands, cartwheels, walkovers; all jumps	Leaps, jumps, cartwheels, handstands	Standing tumbling
3	Handspring to land on mats on back (drills)	Routine over pit	High beam handstands, cartwheels, walkovers; Low beam handsprings	Standing tumbling, roundoff back handsprings	Running tumbling onto resi (Saltos)
4	Limited reps Tsuk and Yurchenko to soft mat	Routine no dismount	High beam handsprings, Low beam series	Running tumbling with Saltos	
5	Land on soft mat only	Dismount on resi	Dismounts on resi, series on high beam	Full Routines	
6	Full vault	Full routines	Dismounts, full routines		

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Table 8. Return to play after lower extremity injury (Levels 8 and 9)

Step	*Vault*	*Bars*	*Beam*	*Floor*	*Tumble Track*
1		Strap Bar/ Pit bar – no dismounts	Balance work, straight jumps, turns	Turns, straight jumps, low impact choreography	Jumps, single handsprings
2	Sprints; Snap down stretch jump stick off block; Progress to back tuck stick off block	Dismount into Pit, swinging skills	Low beam handstands, cartwheels, Walkovers; all jumps	Leaps, jumps, roundoff back handsprings, front handsprings	Running tumbling with single saltos
3	Sprints and board drills	Release moves over pit	High beam handstands, cartwheels, walkovers; Low beam single handsprings	Standing tumbling, back tumbling with single saltos, front handsprings and saltos	Twisting
4	Timers - tsuks, handsprings	Low level dismount to mat in pit, release moves (spotter as needed)	High beam single handsprings, low beam acro series	Back tumbling with twisting	Double backs
5	Timers- Yurchenkos	Full dismount to mat in pit, single Salto dismount to regular mat	Dismounts on resi, high beam acro series	All tumbling	
6	Flip vault onto soft mat, no twisting	Full dismount to regular landing mat	Dismounts onto regular mats	Full routines	
7	Full vault onto regular mat	Full routines	Full routines		

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Table 9. Return to play after lower extremity injury (Level 10)

Step	*Vault*	*Bars*	*Beam*	*Floor*	*Tumble Track*
1		Strap Bar/ Pit bar – no dismounts	Balance work, straight jumps, turns	Turns, straight jumps, low impact choreography	Jumps, single handsprings
2	Sprints	Dismount into Pit, swinging skills	Low beam handstands, cartwheels, Walkovers; all jumps	Leaps, jumps, roundoff back handsprings, front handsprings	Running tumbling with single salto
3	Sprints and Board drills; roundoff whips off springboard into pit	No regrasp/catch; Release moves over pit	High beam handstands, cartwheels, walkovers; Low beam single handsprings	Standing tumbling, back tumbling with single Saltos, front handsprings and Saltos	Twisting skills
4	Timers - Tsuks, handsprings	Low level dismount to mat in pit, release moves (spotter as needed)	High beam single handsprings, low beam acro series	Back tumbling with twisting	Double backs
5	Timers- Yurchenkos	Full dismount to mat in pit, single salto dismount to regular mat	Dismounts on resi, high beam acro series; punch fronts	Double saltos	Twisting double backs, most difficult skills
6	Flip vault onto soft mat, no twisting	Full dismount to regular landing mat	Dismounts onto regular mats	All tumbling	
7	Full vault onto regular mat	Full routines	Full routines	Full Routines	

Table 10. Return to play after back injury (Levels 5 and below)

Step	*Vault*	*Bars*	*Beam*	*Floor*	*Tumble Track*
1		Hanging	Turns, leaps, jumps	Turns, jumps	Round-offs
2		glide swings, low bar kips	Cartwheels, handstands	Cartwheels; Handstands	Single front and back handsprings
3	Running/sprinting	Hip circles, cast to horizontal	Dismounts, Back roll to handstand	Leaps, roundoffs	Round-off back handsprings
4	Hurdles, board drills	High bar tap swings, individual skills, dismounts onto soft mat	Back handsprings	Front/back handsprings, back extension rolls, aerial	Front and back saltos
5	Handspring onto soft mat/ handstand fall	Full routines	Walkovers (if performed)	Walkovers, punch front, back salto	
6	Full vault		Full routines	Full routines	

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Table 11. Return to play after back injury (Levels 6 and 7)

Step	*Vault*	*Bars*	*Beam*	*Floor*	*Tumble Track*
1		Hanging	Turns, basic jumps (low impact)	Turns, basic jumps	
2		Glide swings, low bar kips	Cartwheels, handstands	Cartwheel, Handstands	Roundoffs
3	Running/sprinting	Hip circles, clear hips, cast to horizontal	Advanced jumps, leaps, roundoffs	Leaps, roundoffs	Round-off back handspring and front handsprings
4	Hurdles, board drills	High bar tap swings / kip, cast to handstand without arch	Back handsprings on low beam	Front/back handsprings	Add saltos
5	Handsprings	Giants, flyaways	Dismounts; back handsprings on high beam	Walkovers, saltos (back tucks, punch fronts)	
6	Tsuk and Yurchenko timers to soft mat	Full routines	Walkovers, Acro series	Front handspring front tuck, layouts	
7	Full vault		Full routines	Full routines	

Table 12. Return to play after back injury (Levels 8, 9, and 10)

Step	*Vault*	*Bars*	*Beam*	*Floor*	*Tumble Track*
1		Hanging	Turns, basic jumps (low impact)	Turns, basic jumps	
2		Glide swings, low bar kips	Cartwheels, handstands	Cartwheel, Handstands	Roundoffs
3	Running/sprinting	Hip circles, clear hips, cast to horizontal	Advanced jumps, leaps, roundoffs	Leaps, roundoffs	Roundoff back handspring and front handsprings
4	Hurdles, board drills	High bar tap swings / kip, cast to handstand without arch	Back handsprings, side aerials	Front/back handsprings	Add tucks and layouts
5	Handsprings	Giants, basic flyaways	Dismounts, saltos	Walkovers, saltos (back tucks, punch fronts)	Full tumbling
6	Tsuk timers	Release moves	Layout step-outs, front aerials	Front handspring front tuck, layouts	
7	Yurchenko timers, flip tsuks and handsprings	Dismounts, stalders, toe-on skills	Full routines	Saltos, twisting, double backs	
8	Full vault	Full routines		Full routines	

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CONCLUSION

Women's artistic gymnastics grows increasingly popular and is consistently found to have a high rate of injury in both practice and competition when compared to other sports. Medical providers, physical therapists, coaches, athletic trainers, parents, and all those caring for these athletes face complex decisions when guiding these athletes on return to play. This complexity stems from the multiple competitive events that these athletes perform as well as the wide variety of injury types they suffer from. Finally, the various level-based systems used by gymnastics organizations and governing bodies further complicate the return to sport requirements for artistic gymnastics athletes.

This paper explors several considerations regarding RTP recommendations for female artistic gymnasts. We provide specific RTP protocols which, when used in conjunction with other published RTP literature such as that by Sweeney et al., may assist medical staff and all those involved in the care of female gymnasts in guiding them safely back to sport.

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Conflict of Interest Statement

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