Returning to Sport After Gymnastics Injuries

Emily A. Sweeney, MD[1,2]; David R. Howell, PhD, ATC[1,2]; David A. James, DPT, OCS, SCS[3,4]; Morgan N. Potter, BA[1]; and Aaron J. Provance, MD[1,2]

Abstract

Acute and overuse injuries are a common experience for artistic gymnasts; however, this population has unique needs when returning to their sport after an injury due to the technical demands imposed during gymnastics. We reviewed the current literature regarding return to play (RTP) in artistic gymnasts and developed four goals: 1) to define the guiding principles used to determine RTP in sports, 2) to identify factors that affect recovery progression among gymnasts, 3) to determine how different injury types affect RTP protocols, and 4) to create structured RTP protocols specific to gymnasts based on sex and body part injured. By establishing these guidelines, we hope to provide guidance to medical providers through a standardized approach for returning gymnasts to their sport.

Introduction

Injuries are an unfortunate, but common experience for many athletes. The number and type of injuries in each sport vary, based on the motor and cognitive actions required for each unique sport (1–3). Artistic gymnastics has a particularly high rate of injury; it has the second highest injury rate during practice in collegiate sports, behind only spring football (1). Reported injury rates in gymnastics vary from 1.3 to 9.22 per 1000 exposure hours (1,4,5), which is approximately how many hours an elite gymnast trains per season (6). Although overuse and traumatic injury rates in gymnastics are among the highest of any sport per athletic exposure, there is limited information available to guide health care professionals for returning gymnasts to the highly technical demands of the sport (4).

Sports medicine clinicians face distinct challenges in managing injuries in gymnasts, as these athletes typically begin participation at a young age, and must adhere to unique physical demands to be successful. Many artistic gymnasts start participation in their sport between the ages of 4 and 8 yr (5). As gymnasts progress in their technical skills, training time tends to increase from less than 9 $h \cdot wk^{-1}$ as beginners, to between 20 and 40 $h \cdot wk^{-1}$ as elite gymnasts (4,7,8). In addition, gymnasts tend to be engaged throughout the year without a devoted rest period. Frequently, this uninterrupted and increased training occurs while young gymnasts also are going through many physiological and development changes relating to the adolescent growth spurt and puberty. Developing athletes during this time of life, especially when combined with long training hours, may be particularly vulnerable to injuries (9,10).

Overall, more than half of gymnastics injuries are to the lower body and are typically strains, sprains, or overuse-related (4). Using the National High School Sports-Related Injury Surveillance System, Reporting Information Online (RIO) database, researchers showed female gymnasts had the second highest rate of stress fractures (7.43 per 100,000 athlete exposures), just behind female cross country athletes (10.62 per 100,000 athlete exposures) (11). Furthermore, female gymnasts also had the highest rates of patellar instability injuries (6.19/100,000 athlete-exposures) of all high school athletes (12). The use of rehabilitation programs to treat these and other injuries is imperative to safely return athletes to their sport, reduce their risk of reinjury, and avoid chronic issues later in life.

Many sports medicine clinicians utilize return to play (RTP) protocols based on general guidelines for an injury or specific to a sport. These protocols allow athletes to progress from the time of injury until they can participate in their sport in a safe and effective manner. Return to play protocols typically aim to minimize pain levels, build strength, and improve range of motion while reducing reinjury risk in a stepwise and progressive manner (13). Because there tends be more reliance on a "one size fits all" approach for RTP protocols, gymnasts may have difficulty progressing back to the unique movements, high forces, and the different events in their sport. Current literature is scarce related to systematic RTP guidelines for gymnasts, making RTP decisions for these athletes difficult for clinicians.

Based on the stated gaps in the literature, our review had four purposes. First, we sought to define the guiding principles used to determine RTP in sports. Second, we identified factors that affect recovery progression among injured

[1]Children's Hospital Colorado, Sports Medicine Center, Aurora, CO; [2]University of Colorado School of Medicine, Aurora, CO; [3]University of Colorado School of Medicine, Physical Therapy Program, Aurora, CO; and [4]Cascade Sports Injury Prevention and PT, Lakewood, CO

Address for correspondence: Emily A. Sweeney, MD, Children's Hospital Colorado, 13123 E. 16th Ave, Box 060, Aurora, CO 80045; E-mail: Emily.Sweeney@childrenscolorado.org.

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artistic gymnasts. Third, we determined how different injury type affects RTP protocols. Fourth, we created a structured RTP protocol specific to male and female artistic gymnasts for health care providers to use in clinical practice. By addressing each of these purposes, we provided RTP guidelines for artistic gymnasts who have sustained injuries to the back, upper extremity and lower extremity, stratified by sex. By establishing these guidelines, future studies will be able to address the efficacy of such standardized approaches and determine if further changes are required.

RTP Principles

Among the many challenging aspects of clinical care within sports medicine, one particular challenge is determining the appropriate time when a RTP progression can be initiated and when full sport participation clearance can be given to an individual athlete. This is difficult for clinicians because each sport has a diverse set of demands, such as the motor skills required for successful completion and injury avoidance. In addition, each injury requires a different rehabilitative protocol and expected recovery timeline. Although it is important to institute a rehabilitation program for each individual athlete, this is difficult as sport- and body region-specific protocols and evidence-based guidelines are not widely available in the existing literature (13).

The development of sport-specific guidelines allows for individualized decision making and direction for rehabilitative pathways. This is typically done by a progressive and stepwise approach to ensure that the athlete does not return to sport while still vulnerable to further injury. Thus, recommendations have stated that it may be necessary to stay within a given step on the RTP timeline for a longer period if the athlete does not demonstrate the ability to progress to the next stage (14). While slow progression is not necessarily concerning, clinicians also may monitor progression through RTP protocols to identify if a patient may benefit from a specialist referral.

Several systematic reviews have provided qualitative syntheses of the literature pertaining to RTP following different orthopedic injuries, such as after anterior cruciate ligament reconstruction (15), clavicle fracture (16), tibial stress fracture (17), or ankle fracture (18). In addition, there has been a focus in the literature surrounding sport-related concussion in recent years. Although there are widely published RTP concussion guidelines (14,19,20), there is no evidence that RTP guidelines affect injury prognosis (21), and many athletes do not follow these recommendations (19,21). Many of these concussion protocols do not address factors specific to gymnasts; however, there is one recent report that provides guidelines specifically for artistic gymnasts who sustain a concussion which include the following steps (20):

1. No physical activity
2. Light aerobic activity: 10–15 min of walking or stationary bike
3. Moderate aerobic activity: 20–30 min of jogging and body weight squats and push-ups (1 set of 10 reps)
4. Vertical work: handstand skills (variable depending on level)
5. Intro level tumbling and bar skills; basic vaults
6. Full practice (after medical clearance)
7. Unrestricted workouts and competition

Although this represents a step toward reducing the reliance on universal and non-individual approaches to reintegration in gymnastics, it also is necessary to understand how RTP demands may differ by injury type within the sport of gymnastics. Therefore, there is a clear need to develop stepwise gymnastics-specific RTP protocols beyond concussions. This development may assist sports medicine clinicians in appropriately guiding artistic gymnasts back to sport in a safe and appropriate manner.

Factors Affecting Return to Sport in Gymnastics

The diverse set of competition apparatus and specific body movements required for a successful artistic gymnast make the physical demands of the sport distinct. While lower extremity musculoskeletal injuries and spine injuries typically account for greater than 60% of the injuries sustained in gymnastics, all joint regions are at risk of injury during gymnastics (6,22,23). Therefore, it becomes challenging to rest or protect specific tissues during the recovery and RTP progression following an injury.

In addition to the whole body demands of the sport, artistic gymnastics also exposes the body to a high volume of force through repetitive stress and through compressive, distractive, and rotational forces. During events, varying levels of accelerations and forces are imparted onto musculoskeletal structures, potentially leading to injury. For example, during basic skills on the uneven bars, the spine can experience both compressive and distractive forces several times the gymnast's body weight (24,25). This experience is not only responsible for unique injuries such as vertebral end plate damage of the spine, but also indicates that both compressive and distractive, forces should be considered during the construction of RTP guidelines and athlete progression following most gymnastics injuries. Providing guidelines for progressive increase in both intensity and volume of these specific forces is key to allowing appropriate tissue adaptation as the athlete returns to sport.

Many artistic gymnasts feel pressure to return to gymnastics quickly and often before they are physically and mentally ready after an injury. In addition, some gymnasts feel they should train through pain and may not divulge pain as they RTP. Therefore, medical providers should encourage clear and open communication between the athlete, coach and medical team during the RTP process to keep the athlete healthy.

The relatively young age of the vast majority of artistic gymnasts is another variable to consider in guiding return to sport (26). Furthermore, the skeletal maturity of athletes is variable across the competitive levels of the sport and in males versus females which can affect injury patterns and subsequent RTP decision. In addition to learning skills, improving technique, and developing strength, young gymnasts undergo a rapid development in growth (*i.e.*, height and weight) and neurocognition. This puts high demands on the physical and cognitive systems during this period of life. The young age of many gymnasts also results in unique injuries such as apophysitis, growth plate fractures, and avulsion fractures that are critical to consider in light of the high incidence of repetitive stress-type injury in the sport (6,22,23). The volume of repetitions and adequate recovery time

between bouts of exposure, as well as nutritional and psychological health, become paramount in managing successful progressive return to sport following injury.

While it is beyond the scope of this paper to describe in detail the specific skills that must be performed to achieve each progressive level of gymnastics, there are many reasons to consider the level at which an athlete is training when returning him or her to gymnastics. First, skills required at each level may put very different demands on healing tissues (*e.g.*, impact, torsion, rotation). Second, the athlete may be competing with one set of skills while training a separate set of skills necessary for the next level of competition. Finally, the number of hours trained per week typically increases with level of competition. Thus, as a gymnast progresses to higher levels of competition, the technical skill expected for tumbling, release moves on bars, and dismounts from all apparatus becomes much higher, as do the potential forces experienced by the body. Medical providers should have a basic understanding of which skills the athlete will be training on returning to full sport participation to provide appropriate guidance regarding specific skill completion or avoidance. Tables 1 and 2 provide a general guideline of many skills required to progressively return to each event in gymnastics, but are not specific to each level of completion.

The process of acquiring a new skill not only puts increased forces on tissues, but it often involves higher repetitions and inherently requires more energy to perform than a proficient skill (27–29). In addition, psychological factors such as anxiety, fear of decreased performance, and fear of reinjury have been established as some key barriers to successful return to sport following injury (30,31). As a means to instill progressive levels of confidence, it has been advocated to initiate return to sport with previously mastered skills (32,33). They may then slowly begin training the skills they were working to acquire one skill at a time. Progressive volume of exposure also is critical in RTP protocols for gymnasts. An artistic gymnast can train anywhere from 3 to 6 $h \cdot wk^{-1}$ in the recreational levels to 30 to 40 $h \cdot wk^{-1}$ for the level 10 or elite gymnast (7,8). If an injured gymnast is cleared to do certain activities or events, he or she should still avoid overtraining that event to avoid a new overuse injury. Then, as the gymnast progresses back to more skills, slowly increasing the amount of time training will allow for progressive adaption of other non-injured joints and tissues. Thus, modifying and progressing time of training relative to these expectations will be critical for successful return to sport and to decrease the risk of reinjury or onset of new acute or overuse injury.

A factor connected to the skills being trained is the constant evolution of scoring and rules within the sport of artistic gymnastics. From year to year, the point value given to a specific skill may be changed, and thus the athletes may have to change the skills they are performing to attain the score they need to compete successfully. In addition, rules regarding body positions during skills and on landings may put the athletes at greater risk for injury. For example, more vertical torso and knee positions when landing dismounts, vaults, and tumbling skills is often rewarded with more points, but there is evidence that this position increases joint reaction forces throughout the lower extremity joints and spine (24,25) and is linked to significant knee injuries (25,34–37). As such, during RTP progression following lower extremity or lumbar spine injury, educating the athlete to land with more knee and hip flexion to reduce forces may be a beneficial strategy.

Injury Type and RTP Protocols

After injury, clinicians should consider the type of the tissue injured, body part injured, and type of injury (overuse vs. traumatic/acute) to successfully guide gymnasts in their RTP protocols. When considering the specific type of tissue injured, it is helpful for clinicians to divide them into two categories: tissue that is most impacted by compressive forces (*e.g.*, cartilage/joint surface, bone) and tissue that primarily provides power, force, or stability (*e.g.*, musculotendinous unit, ligament).

Tissue impact alteration can be considered using two mechanisms during the RTP progression in gymnastics: utilizing equipment that reduces impact forces during landing (tumble track/trampoline, rod floor, mats) and using momentum to transition into and out of a skill. For example, initially a gymnast would tumble a series of skills on a tumble track (*e.g.*, a long trampoline) before moving to the floor. He or she would then progress to individual skills (*e.g.*, back handsprings or saltos) on the regular floor and then on the beam. Finally, the gymnast would complete more complex skills, such as dismounts or vaults. When considering force production and stabilizing tissues, movements would start on a stable surface in a slow, controlled manner working toward fast or ballistic movement on a compliant surface. For example, after an ulnar collateral ligament injury, a gymnast should perform static handstands on a stable surface, such as the regular competitive floor, before progressing to a more dynamic handspring skill on an unstable surface, such as a trampoline. As previously mentioned, when considering repetitive stress injuries, the most critical consideration is volume of training allowing for tissue recovery and adaptation between bouts of exposure. Both the number of exposures per training session and number of training days per week will progressively increase over the course of weeks to months depending on the injury.

As a result of the variety of demands put across joint regions by the events in gymnastics, it is not sufficient to lump multiple joint regions together for return to sport protocols. Thus, we have created RTP protocols for lower extremity, back, shoulder, elbow, and wrist in both male and female artistic gymnasts (Tables 1 and 2). An injury to some joint regions, such as lumbar spine or hip, will require specific progression of skills on all events. However, an injury to other regions such as ankle or knee, may allow for training nearly all skills on uneven bars for females and on high bar, parallel bars, pommel horse, and rings for men as long as the gymnast is performing skills they have previously mastered early in the RTP process. Strength and flexibility is a large part of a gymnast's training; however, we have not included this in our RTP protocols as the number of conditioning exercises that are possible is so extensive that it is beyond the scope of this article. Nevertheless, injured gymnasts may be asked to do very long periods of conditioning or flexibility which could lead to a new injury. Therefore, medical providers, coaches, and gymnasts should discuss and plan for an appropriate amount of time, exercises,

Table 1.
Return to gymnastics progressions for females.

Wrist	Apparatus				
Step	Vault	Uneven Bars	Balance Beam	Floor	Tumble Track
1		Hang on bar 10–60 s		Push-up with shoulder shrug (protraction) ×10–15 Push-up position rock forward and back ×10–15	
2		Tap swings on bars (~3 sets of 5)		Handstand hold against the wall ×10–60 s (facing wall will be easier on wrist than facing away from wall in the handstand position)	
3				Free standing handstands Cartwheels on floor[a]	Roundoffs ×10
4		Glide and long hang kips[b]		Press to handstand (up to 10) Front and/or back walkovers (up to 10)	Roundoff, back handspring (may add single saltos[c])
5		Cast handstand[d] and back giants[e]	Cartwheels and handstands	Roundoffs[a] Pirouetting skills	Front handsprings (may add single saltos[c])
6		Clear hips and Stalders[f]	Front and back walkovers (progressing from low to high beam)	Roundoff, back handspring (add single saltos[c])	Standing back handsprings
7	Handstand hops and blocking drills on floor (use softer mats initially if gymnast had impact type injury)	Front giants[e] Pirouetting skills[g]	Standing back handspring on a line	Standing back handsprings Front handsprings	
8	Handspring and Tsuk[a,h] timers Roundoff entry only for Yurchenko[i]	Release skills Eagle giants[j]	Roundoffs and back handsprings (progressing from low to high beam)		
9	Yurchenko[i] timers Flipping handspring and Tsuk[h] vaults		One arm skills[a] (*e.g.*, one arm back handspring)		
10	Flipping Yurchenko[i] vaults				

Elbow	Apparatus				
Step	Vault	Uneven Bars	Balance Beam	Floor	Tumble Track
1		Hang on bar 10–60 s (may need to delay to step 2 or 3 for elbow stability issues)		Shoulder shrug (protraction) in push-up position ×10–15 Handstand at wall 10–60 s Front and back walkovers (up to 10)	
2				Push-up with shrug (protraction) ×10–15 Cartwheels[a] (up to 15)	Roundoff[a] ×10
3		Tap Swings (10–20) (may need to delay until step 4 for elbow stability issues)		Press to handstand	Roundoff, back handspring Front handsprings (May add single saltos[c])
4			Walkovers and cartwheels on low then high beam	Roundoff, back handsprings and front handsprings (may add saltos[c])	Standing back handsprings
5		Glide and long-hang kips[b] Cast[d] to handstands	Roundoff and back handsprings on line on floor	Pirouetting skills[g]	
6	Handstand hops/blocking drills	Back giants[e] and circling elements Dismounts	Roundoff and back handsprings		
7	Handsprings Roundoff entry for Yurchenkos[i]	Pirouetting skills[g]			
8	Yurchenko[i] and Tsuk[a,h] vaults	Front[e] and eagle[j] giants Release elements			

Shoulder	Apparatus				
Step	Vault	Uneven Bars	Balance Beam	Floor	Tumble Track
1		Hang on bar ×10–60 s	Leaps and jumps	Shoulder shrug (protraction) in push up position ×10–15 Handstand hold against wall ×10–60 s Cartwheels[a] (10–15)	
2		Cast[d] to horizontal	Cartwheels Handstands		Roundoffs[a]
3		Tap Swings (~10–20) Kips[b] and casts[d] to handstand	Roundoffs[a]	Walkovers Roundoffs[a]	Roundoff back handsprings Front-handsprings (may add single saltos[c])

4		Clear hips and Stalders[f]	Walkovers (start on low beam)	Roundoff back handsprings Front handsprings (may add single saltos)	Standing back handsprings Twisting saltos[c]
5	Handstand hops and blocking drills	Back giants[e]	Round off to dismount Saltos[c]	Standing back handsprings Pirouetting skills[g]	Add double saltos[c]
6	Handspring and Tsuk[a,h] timers Roundoff entry for Yurchenkos[i]	Front giants[e] Pirouetting skills[g]	Back handsprings		
7	Yurchenko[i] timers	Release moves		Twisting and double saltos[c]	
8	Flip all vaults	Eagle giants[j]			

Back	Apparatus				
Step	Vault	Uneven Bars	Balance Beam	Floor	Tumble Track
1		Hang on bar 10–60 s	Turns Kicks forward and sideways	Handstand against wall ×10–60 s Cartwheels Straight jumps with good landing technique	Roundoffs
2		Glide and long-hang kips[b]	Cartwheels Handstands	Tuck, straddle and pike jumps with good landings	
3		Tap Swings (10–20) Kip[b] to cast[d] handstand (lower level gymnasts may need to delay this step if not proficient) Clear hips and Stalders[f]	Basic jumps	Leaps and split jumps (without arch)	Roundoff back handsprings Front handsprings
4		Back and front giants[e] Dismount timers onto soft mat	Roundoffs Leaps and split jumps (without arch)	Roundoff back handsprings Front handsprings	Standing back handsprings Nontwisting saltos[c] (no double layouts); land on soft mat
5	Handspring and Tsuk[h] timers onto soft mat	Limited release moves (no Tkatchev, Pak, or hechts which require arching)	Back/front handsprings on line on floor Dismount timers onto soft mat	Single salto[c] without twisting (standing and tumbling) Leaps and jumps with arch	Twisting saltos[c]
6		All release skills Dismounts onto regular mats	Back handsprings Leaps and jumps with arch	Twisting skills Walkovers (if required)	Double layouts
7	Yurchenko[i] timers onto soft mat	All skills	Layout step outs Saltos[c] on the beam	Double layouts Walkovers on line (if required)	
8	Start flipping vaults onto soft mat		Walkovers (if required)		

Lower Extremity *Impact-related Pathology*					
		Apparatus			
Step	Vault	Uneven bars	Balance beam	Floor	Tumble track
1		Strap bar and pit bar without dismounts Basic skills on regular bars	Balance work Turns Straight jumps with good landing technique	Turns and low-impact choreography Straight jumps with good landing technique	Jumps Basic tumbling passes with landing in pit/resi-mat
2		Dismounts into pit All swinging skills	Low beam jumps and leaps Low beam cartwheels, handstands and walkovers	Leaps and jumps Roundoff back handsprings Front handsprings (use rod floor if possible)[k]	Standing individual skills (handsprings, tucks, etc.) Twisting skills
3	Run throughs	Release moves over pit	High beam: Balance work, jumps and leaps; Cartwheels, handstands and walkovers Floor beam: flight series with hands	Individual skills Roundoff back handspring to single salto[c] onto soft mat Front handsprings and front saltos[c]	Double salto[c] skills on soft mat
4	Limited volume running and board drills Handspring and Tsuk[h] timers	Low-level dismount to mat in the pit Release moves (with spotter as needed)	Tumbling (acro) series on low beam	Basic tumbling/ twisting skills onto regular floor Front tumbling passes	
5	Yurchenko[i] timers	Full dismount to mat in pit Single salto[c] dismount to regular landing mat	High beam tumbling (acro) series Dismounts into pit/resi mat	Double saltos[c]	
6	Flipping onto soft mat without twists	Dismounts onto regular mats	Dismounts onto regular mats	Full progression	
7	Full vault onto regular mat				

Lower Extremity *Stability-related Pathology*					
		Apparatus			
Step	Vault	Uneven Bars	Balance Beam	Floor	Tumble Track
1		Strap bar and pit bar; no dismounts Basic skills on regular bars	Balance work Turns Jumps with 2-foot landings without turns Handstands, cartwheels and walkovers	Leaps and jumps without turns Standing back handsprings	Jumps Jump to firm surface with good landing technique

2		Nontwisting dismounts to regular mat	Low beam single leg landing leaps Back and front handsprings	Front handsprings Roundoff back handsprings
3	Run throughs	Increasing difficulty of skills, spotted if needed to avoid unstable landings	High beam balance skills, jumps and leaps Tumbling (acro) series on low beam	Single saltos[c] without twisting on regular floor
4	Tsuk[h], handspring and Yurchenko[i] timers to back	Progress to regular dismounts and release moves	Tumbling (acro) series on high beam Roundoff rebound off beam	Basic twisting and double salto[c] skills
5	Basic flipping vaults (no twisting)	Increasing difficulty of skills and dismounts with twisting	Dismounts without twisting to regular mat	Gradually increase to full skills
6	Full vaults		Twisting dismounts	

[a]If the leading arm is the gymnast's injured arm, this may be more difficult.

[b]Kip: Gymnast swings from under the bar then, pushing down on the bar, ends in a front support with the bar at her hips and hands next to her thighs.

[c]Salto: A front or back flip without hands in a tuck, pike, or straight position.

[d]Cast: Gymnast starts in front support and swings legs backwards into a handstand position.

[e]Giants: Circling backward or forward around the bar with the body extended straight in a handstand position.

[f]Stalders: Backward or circling element in which gymnast is in a straddle-pike position without touching her feet to the bar.

[g]Pirouetting skills: If pivoting base arm is the injured arm, this may be more difficult.

[h]Tsuk: (Tsukahara) A vault in which the gymnast hits the springboard then does a half turn (roundoff) onto the vault and then flips backwards off the vault.

[i]Yurchenko: A vault in which the gymnast does a round-off onto the board then jumps backwards onto her hands on the vault and then flips backwards off the vault.

[j]Eagle giants: Gymnast circles forward around the bar but forearms are fully pronated with shoulders internally rotated so that palms are facing upward (thumbs away from the body).

[k]Rod floor: A rod floor is slightly bouncier and has more compliance than a competitive floor, but has less compliance than a tumble track or trampoline.

Table 2.
RTP gymnastics progression for males.

Wrist	Apparatus						
Step	Floor	Pommel Horse	Rings	Vault	Parallel Bars	High Bar	Tumble Track
1	Push-up with shoulder shrug (protraction) ×10–15 Push-up position – rock forward and back ×10–15		Hang on rings 10–60 s			Hang 10–60 s	
2	Handstand hold against the wall ×10–60 s (facing wall will be easier on wrist than facing away from wall in the handstand position)					Tap swings on bars (~3 sets of 5)	
3	Free standing handstands Cartwheels[a]				Under bar hangs		Roundoffs[a]
4	Press to handstand		Swings		Support swings Above bar basics	Long hang kips[b]	Roundoff, back handsprings (may add single saltos[c])
5	Roundoffs[a]	Basic circles on mushroom[d] Scissors	Front support holds		Above bar sequences[a]	Kips[b] and casts[e] to handstand	Front handsprings (may add single saltos[c])
6	Roundoff back handsprings (may add saltos[c])	Double pommel basic skills	Handstand and basic swinging skills			Clear hips and Stalders[f] Back giants[g]	Standing back handsprings
7	Standing back handsprings Front handsprings	Single pommel basics[a] Leather basics	More difficult swinging skills	Handstand hops and blocking drills on floor (use softer mats initially if gymnast had impact type injury)	Under bar drills	Front giants[g] and pirouetting[a] skills	
8	Flare/circle[h] and hold skills	More difficult skills and single pommel work	Strength and planche[i] holds	Handspring and Tsuk[a,j] timers	Under bar skills	Release moves Eagle[k] and invert[l] skills	

9		Connect multiple skills		Yurchenko[a,m] timers Flipping handspring and Tsuk[a,j] vaults	Release skills		
10				Flip Yurchenko[a,m] vaults			
Elbow	Apparatus						
Step	Floor	Pommel Horse	Rings	Vault	Parallel Bars	High Bar	Tumble Track
1	Shoulder shrug (protraction) in push-up position ×10–15 Handstand at wall 10–60 s		Hang on rings 10–60 s (may need to delay to step 2 or 3 for elbow stability issues)			Hang on high bar 10–60 s (may need to delay to step 2 or 3 for elbow stability issues)	
2	Pushup with shrug (protraction) ×10–15 Cartwheels[a] (up to 15)						Roundoff[a] ×10
3	Press to handstand Roundoffs[a]				Under bar hangs (may need to delay for elbow stability issue	Tap swings on high bar (may need to delay to step 4 for elbow stability issues)	Roundoff back handsprings Front handsprings (may add saltos[c])
4	Roundoff back handsprings (may add saltos[c]) Front handsprings		Below Ring swings		Support swings Above bar basics		Standing back handsprings
5	Standing back handsprings		Front support holds	Handstand hops and blocking drills	Above bar sequences[a]	Kips[b] and casts[e]	
6	Flare/circle[h] skills	Scissor skills Circles on mushroom[d]		Handspring timers		Back giants[g] Stalders[f] Dismounts	
7	All tumbling	Basic skills on 2 pommels and the leather	Handstand and basic swinging skills	Tsuk[a,j] and Yurchenko[a,m] timers	Pirouette skills[a] Under bar basics	Pirouette skills[a]	
8		Single pommel work[a]	More difficult swinging skills	Handspring vaults	Under bar skills	Front giants[g] Release skills	
9		Connect multiple skills	Strength and planche[i] holds	Tsuk[a,j] and Yurchenko[a,m] vaults	Release skills	Eagle[k] and invert[l] giants	

Shoulder	Apparatus						
Step	Floor	Pommel Horse	Rings	Vault	Parallel Bars	High Bar	Tumble Track
1	Shoulder shrug (protraction) in push up position ×10–15 Handstand hold against wall ×10–60 s Cartwheels[a] (10–15)		Hang on rings 10–60 s			Hang on high bar 10–60 s	
2	Push up with shrug (protraction)					Cast[e] to horizontal	Roundoffs[a]
3	Roundoffs[a]				Support swings Under bar hangs	Below bar tap swings	Roundoff back handsprings (may add saltos[c]) Front handsprings
4	Roundoff back handsprings (may add saltos[c]) Front handsprings	Scissor swings Mushroom[d] circles	Front support hold Below ring swings		Above bar drills	Kips[b] Cast[e] to handstand	Standing back handsprings Add twisting saltos[c]
5	Standing back handsprings		Handstands	Handstand hops and blocking drills	Above bar skills	Clear hips Stalders[f]	Add double saltos[c]
6	Add twisting and double saltos[c]		Bail drills	Handspring and Tsuk[a,j] timers	Advance above bar sequences and under bar skills, no Tippelt	Back giants[g] Dismounts	
7	Flare/circle[h] skills	Basic skills on 2 pommels and on the leather	Basic strength skills	Yurchenko timers[a,m]	Pirouette skills[a] Advance under bar skills	Pirouette skills Front giants[g]	
8		Single pommel work[a]	Moderate strength skills Full swing skills and sequences	Flipping vaults	Release moves including Tippelt	Release elements	
9		Connect multiple skills	All strength holds			Eagle[k] and invert[l] giants	

Back	Apparatus						
Step	Floor	Pommel Horse	Rings	Vault	Parallel Bars	High Bar	Tumble Track
1	Handstand holds against wall (10–60 s) Cartwheels Straight jumps with good landing technique						Roundoffs

2	Roundoffs	Scissor swings	Basic swings Front support holds		Above bar support swing basics	Kips[b] Tap swings	Roundoff back handsprings Front handsprings
3	Roundoff back handsprings Front handsprings Flare/circle[h] skills	Basics on pommels and leather, no dismounts	Handstand and basic strength skills Bail drills	Handspring and Tsuk[j] timers	Above bar support swing skills Under bar drills	Cast[e] to handstand (lower level gymnasts may need to delay this step if not proficient) Clear hips Stalders[f]	Standing back handsprings Nontwisting saltos[c] (no double layouts)
4	Add single saltos[c] without twisting Standing back handsprings	All skills and sequences	Back giants	Handspring and Tsuk[j] vaults	Under bar skills, no Tippelt	Back and front giants[g] Dismounts into pit	Add double layouts
5	Add double salto[c] skills	Add dismounts	Front giants	Yurchenko[m] timers	Full dismounts	All release moves	
6	Add twisting skills		Add dismounts	Full vaults	Full under bar skills and Tippelt		
Lower extremity *impact-related pathology*			Apparatus				
Step	Floor	Pommel Horse	Rings	Vault	Parallel Bars	High Bar	Tumble Track
1	Flare/circle[h] and handstand skills Straight jumps with good landing technique	Basics without dismounts	Basics without dismounts Strength skills		Basics without dismounts	Strap bar and pit bar basics without dismounts	Jumps Roundoff back handsprings (add single salto[c]) Front handsprings
2	Jumps with good landing technique Roundoff back handsprings Front handsprings	Full skills with dismounts	Full swing skills Dismount into pit		Full swing work Dismounts into pit	Full swing skills Release moves over pit Dismounts into pit	Standing skills (back handsprings, tucks) Twisting saltos[c]
3	Standing back handsprings and tucks Add single saltos[c] to tumbling passes onto a soft mat		Basic dismounts onto regular mat	Run through	Basic dismounts onto regular mat		Add double salto[c] skills onto soft mat
4	Twisting saltos[c] All front tumbling			Handspring and Tsuk[j] timers		Dismount onto mat in pit	
5	Double saltos[c]		Full dismounts	Yurchenko[m] timers	Releases and dismounts without twisting	Basic dismounts onto regular mat	

6				Flip vault onto soft mat without twisting	Twisting releases and dismounts	Full dismounts	
7				Vault to regular mat			
Lower extremity *stability-related pathology*				Apparatus			
Step	Floor	Pommel Horse	Rings	Vault	Parallel Bars	High Bar	Tumble Track
1	Jumps with good landing technique Standing back handsprings	Basic skills without dismounts	Basic skills without dismounts		Basic skills without dismounts	Strap bar and pit bar basics without dismounts	Jump to firm surface with good landing technique
2	Front handsprings Roundoff back handsprings Standing back tucks	All skills with dismounts	Basic (no twisting) dismounts to regular mat More difficult skills (spot as needed)		More difficult skills (spot as needed)	Basic (no twisting) dismounts to the pit Releases over the pit	
3	Single, nontwisting saltos[c]			Run through	Basic (no twisting) dismounts to regular mat	More difficult skills (spot as needed) Full releases	Twisting and double salto[c] skills to firm surface
4	Basic twisting and double salto[c] skills		Double salto dismounts	Tsuk,[j] handspring and Yurchenko[m] timers	More difficult dismounts	Dismounts to mat without twisting	
5	More difficult tumbling passes		Twisting dismounts	Flip vaults without twisting		Dismounts with twisting	
6				Regular vault			

[a]If injured arm is the lead arm for roundoffs or vaulting, the base arm for pirouettes, above bar swinging skills or for single pommel work, then the progression may be more difficult and may be delayed.

[b]Kip: Gymnast swings from under the bar then, pushing down on the bar, ends in a front support with the bar at his hips and hands next to his thighs.

[c]Salto: A front or back flip without hands in either a tuck, pike, or straight position.

[d]Mushroom: A short cylinder with a rounded top that is a training tool for learning skills on pommel horse.

[e]Cast: Gymnast starts in front support and swings legs backwards into a handstand position.

[f]Stalders: Backward or circling element in which gymnast is in a straddle-pike position without touching his feet to the bar.

[g]Giants: Circling backward or forward around the bar with the body extended straight in a handstand.

[h]Flare/circle: Gymnast circles legs around torso/shoulders while weight-bearing only on the hands.

[i]Planche: Gymnast uses his arm strength to hold his body in a horizontal position.

[j]Tsuk: (Tsukahara) A vault in which the gymnast hits the springboard then does a half turn (roundoff) onto the vault and then flips backwards off the vault.

[k]Eagle giants: Gymnast circles forward around the bar but forearms are fully pronated with shoulders internally rotated so that palms are facing upward (thumbs away from the body).

[l]Invert: Skills with the shoulders fully extended backwards and internally rotated.

[m]Yurchenko: A vault in which the gymnast does a roundoff onto the board then jumps backwards onto her hands on the vault and then flips backwards off the vault.

and repetitions that will be indicated for each individual gymnast based on their level in the sport, maturity level, and injury.

Return to Gymnastics in Clinical Practice

To develop the conceptual understanding of gymnastics injuries, we created a clinical practice guide for systematically returning athletes to artistic gymnastics. This document, which includes progressive return to gymnastics tables, was developed for patients, parents, coaches, physical therapists, athletic trainers, physicians, and other health care providers who are involved in a gymnast's care, whether at a recreational, club, or elite level. Although this development represents a progression toward individualized injury care for gymnasts, it should not be considered the current standard of care, as it is based on clinician opinion and not on original research. This document is only a guide, and is of a general nature, consistent with the reasonable practice of a health care professional. While author agreement exists on the principal messages conveyed by this document, the authors acknowledge that the science of gymnastics injuries is evolving and therefore individual management and RTP decisions remain in the realm of clinical judgment. Individual treatment will depend on the facts and circumstances specific to each individual case and may not be appropriate for every gymnast or every gymnastics injury.

Male and female artistic gymnasts compete in several different events that require different skills and strengths. Therefore, these RTP protocols were developed specifically for anatomic location and sex. Prior to starting each return to gymnastics protocol, the health care provider should confirm that the athlete has minimal to no pain at the area of injury, full and pain-free range of motion, near equal strength of the extremity or joint as compared to the contralateral side and has performed satisfactorily on functional testing (13). These criteria are usually met after completion of a rehabilitation program addressing underlying inflexibility, core weaknesses, inadequate proximal control, lack of proper technique, faulty movement patterns, and/or musculoskeletal deformities placing particular joints at increased risk of injury. Gymnasts with impact-related pathology, such as stress fractures, ankle impingement, apophysitis, and osteochondral defects, should start with connected skills on a tumble track before progressing to the floor and firm surfaces. In contrast, gymnasts with stability-related pathology, such as patellar dislocations, ACL injuries, and ankle sprains, should begin with individual skills on a firm surface and add rotational and twisting skills later in the progression.

Prior to starting a RTP protocol, gymnasts should be aware of additional variables that can affect successful return to gymnastics, such as proper sleep and nutrition. Each protocol should be tailored to the athlete's injury, handedness, skill level, and the skill demands required for their individual events. In addition, gymnasts should start with approximately 50% of the standard number of repetitions of each skill typically performed. The protocol should be stopped with any return of pain during any of the stages.

In Tables 1 and 2, each column represents a different event in which artistic gymnasts compete, as well as a tumble track column. The tumble track is a long trampoline where gymnasts often learn tumbling skills. Each row in the tables represents a new step. Gymnasts should not perform more than one step per day; in fact, some gymnasts may need to stay at a specific step for more than 1 d if there is difficulty completing the indicated skills or if the gymnast had a more severe injury. For each step, the gymnast may add the indicated new skills as listed in the row for all the events. A rest day should follow any stage that has reproduced pain in the area of injury. After a day of rest and complete resolution of pain, the gymnast should start again at the previous, non-painful stage and progress as tolerated. Mild-to-moderate pain or soreness in muscles that resolves within 1 to 2 d of a training session and is not in the area of injury should not cause the athlete to stop the progression through the protocol. If a gymnast reaches a point in which they are not able to progress through the stages due to recurrent pain, the athlete should be referred back to their treating physician.

Conclusions

Artistic gymnasts have a unique set of requirements to successfully participate in their sport. The current literature is limited in guiding these athletes through RTP protocols. We reviewed the literature and created RTP protocols specific for male and female artistic gymnasts based on the body part that was injured. Readers are encouraged to use this guide for the basis of future research studies. In addition, health care providers, patients, parents, and coaches may use this as a guide for prevention of future injuries and to aid gymnasts in a RTP progression after an injury.

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