

ACHILLES RUPTURES AND RETURN TO SPORT IN GYMNASTICS: AN OVERVIEW

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Abstract

Achilles tendon ruptures in collegiate gymnastics have significantly increased in the past few years, with 20 ruptures in the first three weeks of competition alone in 2020 according to Bonanno et al., 2022. Female gymnasts are ten times more likely to tear their Achilles than any other college athletes, with an incidence of 16.73/100,000. Men's basketball has the next highest incidence at 4.26/100,000 (Bonanno et al., 2022). Contributing factors for the increase in ruptures are not well researched or understood. This paper will explore the relevant literature on the risk factors of tears and return to sport protocols. It will touch on early rehab but mainly focus on return to sport testing and progression for gymnastics from a physical therapy perspective. It will explore topics discussed in interviews with numerous sports physical therapists with extensive gymnastics or collegiate athletics experience. Gymnastics is a very technical sport where each athlete has individual skills with different biomechanical requirements; therefore, needs vary between athletes. This paper aims to address the transition phase between the time when surgical protocols allow a return to sport and the actual return to performance during recovery. In this specific domain, there is an ongoing need for prospective, longitudinal studies to investigate testing and outcome measures tailored to gymnastics. These studies can play a crucial role in guiding athletes, trainers, coaches, and therapists in facilitating a safe and effective return to performance after surgery.

Keywords: *gymnastics, Achilles Rupture, Return-to-Sport, Physical Therapy*

INTRODUCTION

Achilles tendon ruptures in collegiate gymnastics have significantly increased in the past few seasons, with a study finding 20 ruptures in the first three weeks of competition alone in 2020 (Bonanno et al., 2022). A study published in 2022, *Factors Associated with Achilles Tendon Rupture in*

Women's Collegiate Gymnastics, investigated rupture rates and risk factors (Bonanno et al., 2022). They found that females engaging in gymnastics are ten times more likely to tear their Achilles tendon than in any other college sport, with an incidence of 16.73/100,000. In men's categories,

basketball was the next most common sport with the injury, showing an incidence of 4.26/100,000. There is currently no published return to sport protocol for Achilles ruptures in gymnastics. Given the significant increase in rupture rates, there is a need for research and collaboration between healthcare providers, coaches, and strength and conditioning staff, to understand the increase in rupture rates and the best way to return these athletes to gymnastics.

The Achilles tendon is the strongest tendon in the body, yet the most ruptured one in the lower extremity (Jarvien et al., 2001 & Shamrock & Varacoola, 2023). The average return to sport timeline for professional athletes is 11 months compared to the six-month recovery for the general population (Johns et al., 2021). Ruptures typically occur in dorsiflexion and knee extension. The more dorsiflexion the ankle is in, the more tension there is on the tendon (Yeh et al., 2020). The injury also commonly occurs with sudden plantar flexion, such as a jump takeoff (University of Wisconsin Sports Medicine). Both positions are common in gymnastics, specifically on backward tumbling takeoffs. According to data collected in a cross-sectional study by Bonanno et. al, 91% of Achilles tears in gymnastics occur on floor exercise, most of which are from a backward tumbling takeoff. This places the athlete in dorsiflexion and knee extension, putting extreme stress and tension on the gastroc-soleus complex and the Achilles tendon. Among athletes who experienced a rupture, 70.9% reported tendon pain in the preceding four weeks (Bonanno et al., 2022). This suggests that with increased interprofessional communication, some of these season-ending injuries may be preventable.

A key rehabilitation objective is to mitigate the risk of a re-rupture. Establishing a robust strength and conditioning foundation that aligns with specific gymnastics skills proves to be one of the most effective strategies. Gymnastics is a very technical sport and there is a lack of evidence-based, gymnastics-specific protocols to guide clinicians. This paper aims to offer a framework for clinicians and coaches to understand the gymnastics-specific considerations in rehabilitating gymnasts. It provides benchmarks utilized by therapists specializing in gymnastics and serves as a starting point for discussions between medical providers and the gymnastics community. The paper also underscores the rising incidence of ruptures, emphasizing the need for further high-quality research in this field.

METHODS

This study looks to combine the current research with expert opinion to serve as a guide for returning to sport in a safe, efficient manner. This study seeks to build upon the discussion started with *Factors Associated with Achilles Tendon Rupture in Women's Collegiate Gymnastics* (Bonanno et al., 2022) by delving into available research concerning rupture rates and risk factors, return-to-sport protocols and testing, and gymnastics-specific considerations. Moreover, the study incorporates insights from interviews with multiple top-level clinicians selected on the basis of their experience in treating gymnasts and proficiency in developing return-to-sport testing batteries. Figure 1 provides a list of clinicians included in this study.

Clinician's Name	Credentials	Current Position/Relation to Topic
Dr. Dave Tilley	DPT, SCS, CSCS, C-PS	-Current clinician at Champion Physical Therapy Waltham, MA -Owner of Shift Movement Science, an educational platform that aims to educate coaches, athletes, and providers about performance, gymnastics rehab, prevention -Co-author of <i>Factors Associated with Achilles Tendon Rupture in Women's Collegiate Gymnastics</i>
Dr. Stacie Barber	PT, DPT, CSCS, DN cert., USAW-L1SP, FRCms	-owner of <i>The Physio Fix</i> in Phoenix, Arizona, a private practice that specializes in gymnastics -special interest in Achilles ruptures
Dr. Whitney Kramer	DPT, PT, SCS	-Therapist at a Duke University outpatient clinic, specializing in gymnastics -head of Duke's outreach program for gymnastics in the Durham Triangle area
Dr. Drew Lukes	PT, DPT, SCS, CSCS	-Sports Physical Therapist through Duke University Athletics -Treats Olympic Sports athletes
Dr. Matt McDougal	PT, DPT, CSCS	-Sports Physical Therapist in Raleigh, NC -specializes in gymnastics and runs an outreach program at a local gym

Figure 1: Clinicians' opinions

RESULTS AND DISCUSSION

Tendon Degeneration

Achilles tendon rupture is multifactorial and the increase in rupture rates calls for more research. Pre-existing chronic tendon degeneration in the form of microtrauma is the most common explanation for rupture. Microtrauma can come from repeated forces, long training hours without adequate recovery, and early specialization. Healthy Achilles tendons are 95% type I collagen, characterized by organized, parallel fibers designed to give high tensile strength. Ruptured and tendinopathic tendons show an increase in type III collagen, unorganized fibers with lower tensile strength (Mansfield et al., 2022).

Gymnastics-Specific Risk Factors

The nature of gymnastics requires extremely high training hours, with elite gymnasts training upwards of 35 hours a

week. Additionally, early specialization in the sport is extremely common. With early specialization, athletes are performing difficult floor passes, such as double backs, at an extremely young age, which is another risk factor for rupture (Bonanno et al., 2022). Gymnasts with a habit of landing "short" on their skills are at a greater risk for developing anterior ankle impingement. Landing "short" puts the talocrural joint in maximum dorsiflexion and large amounts of knee flexion. It occurs when the athlete lacks the height or rotation to complete their attempted skill. This may accelerate the degeneration of the Achilles tendon, leading to an increased risk of rupture (Wertz et al., 2010).

According to *Biomechanics Related to Injury* by Bruggemann and Hume, the force applied to the Achilles tendon during backward tumbling is about 15 times the gymnast's body weight (Bruggemann & Hume, 2013). These forces taken over years of training may have a significant impact on

chronic tendon degeneration (Bonanno et al., 2022). These extreme forces are nearly impossible to replicate in the clinic, which poses the question of how to ensure athletes are ready to take such forces after a rupture.

Gymnastics-Specific Range of Motion

Gymnasts are known for being hypermobile and flexible. Studies show that 62% of gymnasts score greater than four on the nine-point Beighton scale, indicating generalized joint hypermobility. Being hypermobile may be advantageous in gymnastics, as it is a sport based on aesthetics. The more mobile a joint is, however, the more it is at risk of instability. The athlete's ability to control their range of motion and have strong musculature surrounding joints can decrease the risk of injury (Armstrong, 2018).

Dr. Dave Tilley (DPT, SCS, CSCS), the owner of Shift Movement Science and clinician at Champion Physical Therapy in Boston, MA, shared his perspective on post-surgical range of motion. In his experience, about half of gymnasts have difficulty regaining dorsiflexion range of motion after surgery. Younger athletes, such as those with ruptures while still in high school, tend to have an easier time. A possible explanation is that their tissue quality is better, as they have taken less load than college athletes. College athletes are more likely to have changes in their talocrural joints from repeatedly landing short over the years. (Tilley, D., oral communication, 2023). Other factors associated with early range of motion may include surgical protocols, location of the tear, and management of swelling (Tilley, D., oral communication, Feb 2023).

After the protective phase, it is important not to overstretch the tendon. Dr. Lukes (DPT, SCS, CSCS), a DPT for Duke Athletics, spoke about a certain level of tension in the Achilles tendon that is necessary to utilize its ballistic qualities with the stretch reflex, which allows the athlete to generate enough force output for their sport. For this reason, we do not want to overstretch the tendon (Lukes, D., oral communication, Mar 2023). In Tilley's experience, soft tissue work to the gastrocnemius heads has been successful in taking the tension off the Achilles tendon without the worry about overstretching the tendon (Tilley, D., oral communication, Feb 2023). Dr. Matt McDougal (DPT, CSCS), who also works with gymnasts, said he would be cautious performing posterior talocrural joint mobilizations. While the mobilization is thought to help increase dorsiflexion, it may place unnecessary stress on the posterior lower leg in early rehab (McDougal, M., oral communication, Mar 2023).

Creating a Strength and Conditioning Base

A good strength foundation, including a gradual, individualized rehab program is vital when creating a plan of care. Outcome measures help track athletes' progress and the return to sport process. Much of rehab is walking the line between regaining strength and motion without overloading or causing excessive scarring (Lukes, D., oral communication, Mar 2023). This underlines the importance of having a certified practitioner to guide the athletes each step of the way and adjust the program as necessary. A study conducted in 2020, *Exercise Progression to Incrementally Load the Achilles Tendon*, by Baxter et al., investigated

tendon load with different exercises. It is a great reference for better understanding the demands placed on the body for exercise progression (Baxter et al., 2021).

Tilley emphasized the concept of creating an "insurance policy" to optimize the athlete's readiness for gymnastics. This policy involves maximizing the athlete's overall abilities. By enhancing strength and power in various lower extremity movements and plyometrics across the sagittal, frontal, and transverse planes, the risk of re-rupture is reduced. Prior to commencing gymnastics-specific return-to-sport progressions, athletes should engage in high-force, high-volume, single-leg, multi-directional plyometric exercises (Tilley, D., oral communication, Feb 2023). Strengthening within different ranges of a joint is also important because different skills in gymnastics require the body to adapt and perform in various ranges (Barber, S., oral communication, Mar 2023). The landing phase in gymnastics demands greater eccentric breaking force compared to take-offs. Although landings generally don't lead to ruptures, it's crucial to incorporate landing mechanics into the return-to-sport protocol. When reintroducing landings in the gym, a suitable initial step is to perform depth drops onto a firm 20 cm (8-inch) landing mat or a resistance pit landing. Using older mats with excessive variability may elevate the risk of ankle rolling, while transitioning straight to a floor presents a substantial spike in load (Tilley, D., oral communication, Feb 2023).

Blood Flow Restriction (BFR) is the utilization of a tourniquet to decrease blood flow to the affected limb. It is a safe way to increase muscular strength post-injury and it stimulates hypertrophy at significantly lower

loads than without BFR (Hughes et al., 2017). In Achilles ruptures, BFR has been shown to increase calf strength (Hansen et al., 2022). Dr. Barber has also found BFR helpful in early rehab. This is because patients can experience the advantages of working at 80% of their one-repetition maximum (1RM) while actually exerting only 20-30% of their 1RM (Barber, S., oral communication, Mar 2023). Combining traditional resistance rehab programs and BFR may correlate with improved athletic performance (Wortman et al., 2021).

Return to Sport Testing

Outcome measures allow for the tracking of quantitative and qualitative data over time. Many clinicians rely on outcome measures or a performance battery when deciding if an athlete is ready to return to sport. The return to sport is a gradual process, and passing a battery of tests does not automatically clear an athlete for all activities. The introduction of predetermined "benchmarks" before initiating gymnastics-specific skills can aid in reducing the risk of setbacks attributed to pain, weakness, or the possibility of a re-rupture (Tilley, D., oral communication, Feb 2023). Regrettably, there is no universally accepted gold standard, leading to significant variations in clinicians' opinions. The multitude of available tests makes it challenging to determine the most appropriate ones. Opting for tests that align closely with the skill requirements of gymnastics enhances content validity. This section will briefly discuss components of various testing batteries employed by clinicians, along with a few existing return-to-sport protocols. Although the Orthopedic Associates of Hartford has

introduced a return-to-sport protocol for Achilles injuries, it lacks gymnastics-specificity. Nevertheless, it serves as a reference for return-to-sport testing. The protocol establishes criteria for patients to achieve a Limb Symmetry Index (LSI) of 95% or higher on hop tests. The LSI compares performance between the injured and non-injured limbs, offering a baseline for monitoring progress over time. It is applicable to nearly any objective test involving single-leg use, with its validity increasing when used as part of a battery of tests rather than a singular measure (2018 & Orthopedic Associates of Hartford (OAH)).

Strength Testing

Prior to commencing sport-specific activities, Dr. Barber sets a target for her patients to achieve 90% or more limb symmetry in the quadriceps and hamstrings. She assesses heel height during a single-leg heel raise and employs a dynamometer to evaluate soleus strength. For the seated heel raise, her goal is for patients to train at $\frac{1}{2}$ of their body weight at three months post-op, 100% of body weight at six months, and 1.5 times body weight at nine months, with 3-4 sets of 6 repetitions. Dr. Barber also utilizes a handheld dynamometer for measuring quadriceps and hamstring strength, assessing both side-to-side and front-to-back (Barber, S., oral communication, Mar 2023). Duke Athletics incorporates the isometric seated calf raise test, using force plates to evaluate gastrocnemius and soleus strength. Force plates provide metrics on force output, rate of force development, and fatiguability (Lukes, D., oral communication, Mar 2023).

An isokinetic dynamometer is the gold standard for isometric testing and is a part of

rehab at Duke Athletics for quantifying limb symmetry for quadricep and hamstring strength (Lukes, D., oral communication, Mar 2023). Isokinetic dynamometers are very expensive and are not typically available in outpatient clinics; therefore, handheld dynamometers are becoming more common in clinics. A systematic review by Stark et al. concluded that handheld dynameters show minor differences in data collection when compared to isokinetic testing (Stark et al, 2011). The intrarater reliability has also shown to be reliable for lower extremity strength testing (Jackson et al., 2016). If dynamometers are unavailable, it is even more important to look at main lifts and loaded functional activities to watch for asymmetries or weaknesses. These may include but are not limited to squats, single-leg squats, deadlifts, single-leg Romanian Dead Lifts (RDLs), and heel raises.

Plyometrics and Power

A study conducted at Duke University aimed to identify a set of performance metrics that are both valid and efficient for assessing performance and limb symmetry. They employed five tests, with two focusing on plyometrics: the forward single-leg hop and the timed single-leg hop (Lentz, 2020). For squat jump or countermovement jump (CMJ) testing, Champion Physical Therapy and Duke Athletics use force plates, providing quantitative data on peak torque and symmetry, among other values (Tilley, D., oral communication, Feb 2023 and Lukes, D., oral communication, Mar 2023). If force plates are not available, the Sargent vertical jump test is an alternative to assess lower extremity power, though asymmetries may be

more challenging to detect visually compared to using a force plate (Clanton et al., 2012).

Tilley employs specific plyometric exercises as a "tester" to evaluate how athletes respond to the initiation of plyometrics. The sample plyometrics include pogo hops, scissor hops, and in-and-out hops, with 20 repetitions for each. Additionally, athletes perform jogging, skipping, and side shuffling for the length of the floor exercise, with one round consisting of going down and back. This routine involves around 200 ground contacts. If repeated sessions of this regimen do not result in increased symptoms, athletes may gradually progress to performing it on the rod floor three times a week, allowing them to acclimate to the impact of springs once again (Tilley, D., oral communication, Feb 2023).

Balance and Range of Motion

Hartford's protocol recommends achieving greater than 35 degrees dorsiflexion on a Dorsiflexion Lunge Test before attempting sport-specific activities (OAH). The Y-Balance Test is widely employed, providing an overall assessment of single-leg balance and the ability to control dorsiflexion (Shirley Ryan). The anterior part of the Y-balance test assesses ankle stability and range in a dorsiflexed position, crucial for tumbling (Cook et al., 2015). Duke University's study for younger athletes found that in addition to the Y-Balance test, stork balance and single leg stance on a BOSU ball offer concise ways to evaluate performance and leg symmetry (Lentz, 2020). Champion Physical Therapy and the Orthopedic Associates of Harford protocol use the kneeling dorsiflexion test throughout the

rehabilitation process (Tilley, D., oral communication, Feb 2023 and OAH).

Rehab Considerations for Younger Athletes

High school gymnasts experience fewer ruptures compared to collegiate athletes, but occurrences still happen. An obstacle in rehabilitation is the limited availability of weights in most gymnastics gyms. Effectively loading athletes without external load options can be challenging, especially during physical therapy sessions held in the gymnastics gym. Dr. Kramer (DPT, SCS), engaged in outreach at local gyms through Duke Sports Medicine, finds her athletes often use the heaviest weights available in their gyms, but may still not be adequately loaded for the sport's demands (Kramer, W., oral communication, Mar 2023). In response to this, McDougal emphasizes the importance of focusing on functional movement patterns and creatively utilizing external loads when faced with such limitations (McDougal, M., oral communication, Mar 2023). For all athletes, and particularly those without full access to weights, personalized care provided by a practitioner who comprehends the sport's demands is crucial for a successful recovery.

Return to Sport: Gymnastics Skills and Progression

The return to gymnastics skills is a highly individualized process, influenced by factors such as the gymnast's abilities, available equipment, strength levels, and more. There is no universal progression for regaining gymnastics skills, and the following section serves as a guide, with a primary focus on floor exercises due to the significant force exerted on the foot and ankle.

Back tumbling poses the highest risk of Achilles rupture and is typically the last skill to be reintroduced. Progression is influenced by the equipment used, ranging from the bounciest and most forgiving (tumble track) to less forgiving surfaces (rod floor and competition floor). While many gyms have all three, some may lack specific equipment, emphasizing the importance of a robust plyometrics foundation. Collaboration with strength and conditioning coaches can be beneficial in tailoring the best program for each athlete, aiming to enhance strength and plyometric abilities before allowing them to resume tumbling (Tilley, D., oral communication, Feb 2023).

Floor and vault require more force and pounding than bars and beam. Consequently, clinicians often recommend alternating between floor and vault activities during the return-to-sport progression. An example could involve starting with one day of floor exercises and one day of vault per week, gradually increasing to two days each week. As the gymnast regains skills, the tendon's endurance can be assessed, potentially progressing to a single day combining both floor and vault exercises, with responses carefully monitored (Barber, S., oral communication, Mar 2023, and Kramer, W., oral communication, Mar 2023).

Bars

McDougal takes into account the risk of rupture when guiding athletes through their progression. Since there have been no reported ruptures on bars, he permits athletes to proceed unrestricted on the bars before other events (McDougal, M., oral communication, Mar 2023). Dr. Barber adopts a similar approach, allowing her athletes to start bars exercises once they have

achieved full plantarflexion and can tolerate the transition from end-range plantarflexion to end-range dorsiflexion. This consideration is particularly important due to the force exerted on the ankle in plantarflexion during various skills, especially giants. Wearing shoes can assist in alleviating fears and protecting the ankle in the initial stages (Barber, S., oral communication, Mar 2023). Caution is advised on dismounts, and landings should be directed into a pit for as long as necessary.

Beam

If the gymnast has experienced a rupture in their dominant leg, the progression of beam skills may require adjustment. Numerous skills on the beam necessitate a single-leg landing onto the dominant leg. Performing a single-leg landing is challenging due to the increased eccentric loading on the tendon compared to a double-leg landing. A cross-sectional study investigating loading rates and eccentric forces post-tendon rupture found that the involved leg continued to experience increased loading rates, indicating decreased strength up to six years after surgery (Powel et al., 2018). In light of this information, skills involving a two-legged landing or a single-legged landing on the non-injured leg should be reintroduced first. However, when the athlete receives clearance to resume beam skills, they should possess the requisite strength to manage these loads. Fear is a significant factor on beam, and skill progression is therefore largely driven by the athlete (Barber, S., oral communication, Mar 2023).

Vault

9% of tears occur on the springboard impact for a Yurchenko (Bonanno et al., 2022). Additionally, sprinting puts greater

load on the Achilles tendon than jogging during warm-ups. A study on endurance runners demonstrated that dorsiflexion requirements increase proportionally to velocity, with runners exhibiting over 24.5 degrees of dorsiflexion and over 6,043 N.s/km of weighted force on the tendon (Starbuck et al., 2021). To provide context, the general population typically utilizes 10 degrees of dorsiflexion in normal gait (Yoon et al, 2021). This underscores the significance of a robust strength program focusing on the calf and extending up the kinetic chain to the glutes and hamstrings to mitigate some of the imposed load.

A vault runway typically consists of a two-inch pad over concrete with no springs underneath. Many athletes report more pain while sprinting down the runway than in any other event (Barber, S., oral communication, Mar 2023). It is crucial to approach the progression of springboard impacts gradually, acknowledging that longer and faster runs toward the springboard will exert more force on the repair site. Gradually increasing the number of impacts and considering shorter runs or jogging into the springboard for drills are prudent progressions. Initiating vault drills on a Tumble Track and rod floor can be a viable option to manage load. If feasible, setting up a vault off the rod floor into a pit can decrease load by making the springboard "bouncier," thereby reducing forces on the ankle joint. This approach may feel better for the athlete, as they won't have to push off as hard (Barber, S., oral communication, Mar 2023).

Floor

As discussed previously, 91% of ruptures occur on floor. Therefore, it should

be a top priority in planning the return to gymnastics. Clinicians generally suggest that athletes begin tumbling two to three times a week, with a day of rest in between to monitor symptoms and adjust the plan based on progress or regression. The progression should be gradual, with skills not advancing drastically faster than every two weeks. Pain and swelling should serve as key indicators for guiding the process. (Barber, S., oral communication, Mar 2023, Tilley, D., oral communication, Feb 2023, and Kramer, W., oral communication, Mar 2023).

The provided schematic outlines a sample return-to-tumbling plan, considering three variables: skill difficulty, landing surface, and volume. Only one of these variables should be progressed at a time. The plan begins with all skills on the Tumble Track, then transitions to 50% Tumble Track and 50% rod floor. Subsequently, it moves to 50% rod floor and 50% hard floor. Throughout the process, the "hardest skills" are performed on the softest surface. When entering a new phase, activities from the previous phase are conducted on a harder surface 50% of the time. It's essential to understand that a phase does not equate to a week. Both Tilley and Barber recommend at least two weeks exclusively on a trampoline or tumble track at the beginning (Barber, S., oral communication, Mar 2023; Tilley, D., oral communication, Feb 2023). Understanding the biomechanical and physiological requirements of each skill performed before the injury is crucial, as different skills may necessitate varied considerations and timelines.

Phase	Tumble Track	Rod Floor	Hard Floor: onto sting mat, 10 cm (4"), or 20 cm (8") when able
1	2 legged jumps (straight, tuck, split, etc.)	NA	NA
2	50% of time with 2 legged jumps	50% of time with 2 legged jumps	NA
3	NA	50% of time with 2 legged jumps	50% of time with 2 legged jumps
4	Single BHS, front tuck, back tuck, snap down from a block push back	NA	2 legged jumps
5	RO scoop through drills, RO	Single BHS, front tuck, back tuck, snap down from a block push back	2 legged jumps
6	RO BHS, FHS front tuck	50% of time with Single BHS, front tuck, back tuck, RO, snap down from a block push back	50% of time with Single BHS, front tuck, back tuck, snap down from a block push back
7	Multiples of BHS, FHS, front tucks, FHS front tuck/layout	RO BHS, FHS front tuck	Single BHS, front tuck, back tuck, RO, snap down from a block push back
8	RO BHS layout (into pit or resi with scoop through to their back)	RO BHS, FHS front tuck	Single BHS, front tuck, back tuck, RO, snap down from a block push back
9	RO BHS full (into pit), combination front tucks	Multiples of BHS, FHS, front tucks, FHS front tuck/layout	Single BHS, front tuck, back tuck, RO, snap down from a block push back
10	RO BHS double backs (into pit)	RO BHS layout, front layouts	RO BHS, FHS front tuck
11	RO BHS double pikes (into pit, upper-level front tumbling), RO BHS full onto resi landing or 20 cm (8") in the pit	RO BHS layout, front layouts	Multiples of BHS, FHS, front tucks, FHS front tuck/layout (onto resi if able)
12	Double backs onto resi landing or 20 cm (8") in the pit	Back fulls into pit, basic front combination passes	Multiples of BHS, FHS, front tucks, FHS front tuck/layout, RO BHS layout (onto resi if able)
13	Full tumbling onto resi landing or 20 cm (8") in the pit	Back fulls to resi or 20 cm (8") in pit, Double backs into pit	RO BHS BHS, FHS front tuck, RO BHS layout (onto resi if able)
14	Full tumbling onto resi landing or 20 cm (8") in the pit	Double backs into pit	Back fulls, basic front combination passes
15		Double backs onto resi or 20 cm (8") in the pit	Back twisting, Full front tumbling passes
16			Double backs
17			Full tumbling

*BHS = back handspring; FHS = front handspring; RO = round off

Figure 2: Sample Return to Tumbling

CONCLUSION

The primary goal of medical providers is to assist patients in achieving their goals safely and effectively, minimizing the risk of re-rupture. Achieving this goal requires a comprehensive understanding of sport-specific considerations for each skill. Decision-making regarding the return to sports is a complex process, taking into account factors such as mobility, stability, strength, movement quality, power, perception of injury, and confidence, among others. It's crucial to acknowledge the individuality of each athlete, leading to variations in timelines. Effective programs should be progressive, systematic, adjustable, and personalized to optimize athletes' success. This paper serves as a guide for clinicians, aiming to enhance awareness and education on crucial factors in gymnastics rehabilitation. The gymnastics field would benefit from additional research, especially in areas such as the psychological impact of injuries, Blood Flow Restriction, the recent surge in rupture rates, and the establishment of a gold standard for a performance battery.

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