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Abstract

Background: Acute Achilles tendon rupture is an injury that most commonly occurs in the male athletic population. The incidence of Achilles ruptures appears to be increasing globally while the ability to rehabilitate to prior level of function following rupture remains difficult despite surgical and therapeutic advances. While standardized return to sport tests are growing and improving, their validity remains in question. **Purpose:** The purpose of this case study is to investigate the utility of movement screens to assist in the decision to clear an athlete to return to competitive soccer following an Achilles tendon repair. **Case Description:** The patient was a 23-year-old male soccer player who ruptured his left Achilles tendon when starting a sprint during a game. The patient worked with physical therapy for over 5 months with the goal of returning to running and eventually playing soccer. **Outcome Assessments:** The return to sport tests that were utilized are as follows: AlterG Return to Running Testing, Lower Quarter Y-Balance Test (LQYBT), Ankle Hop Testing. **Discussion:** This case report describes the clinical application of numerous movement tests to guide the decision to allow an athlete to safely return to running and sport activity without putting them at risk for reinjury.

Keywords: Athlete; sports medicine; return to sport; Achilles tendon; ankle; orthopedics; physical therapy; rehabilitation

Background

The Achilles tendon, which attaches the gastrocnemius and soleus, or calf muscles, to the calcaneus, or heel bone, is the largest and strongest tendon in the human body. [1] Unfortunately, it is also the most frequently injured tendon in the human body with an increasing worldwide incidence. [2-7] It has been reported that between 9.9-37.3 per 100,000 people in countries across Europe and North America have suffered a ruptured Achilles tendon. [5,7] In a recent US study, the rate was similar at 18 per 100,000 people in the general population. [6] The most common way in which Achilles injuries occur is during sport activities (60-75%), both spontaneous ruptures and tendinitis due to overuse. [4,6,7] Cultural differences account for which sport most of the Achilles ruptures occur during, as basketball and netball (a sport similar to basketball) are the most common in North America and New Zealand, respectively, while soccer is the most common in several European countries. [6,7] Middle-aged males are the most commonly affected group, as they tend to make up the largest portion of the population that is referred to as “weekend warriors”, or those who only occasionally participate in strenuous athletic endeavors. [6,8]

Despite advances in surgical and rehabilitative techniques, reinjury rate remains relatively high. Raikin et al found that 4.9% of patients with an Achilles rupture had a previous rupture of the same tendon in a retrospective study. Interestingly, 85% of these cases opted for non-operative treatment of the affected tendon at the initial injury. [6] In a study of professional soccer players in the UEFA Champions League in Europe, it was found that recurrence of Achilles tendon injuries in elite males was more common following an early return to play. Of 203 Achilles tendon disorders in this cohort, 96% were tendinopathies and 9 were partial or full ruptures. The average off time was 23 ± 37 days for tendinopathies while ruptures caused 161 ± 65 days off. For players who returned earlier than average, their reinjury risk was 31% compared to those who took longer than average to recover, at 13%. [9]

Along with the risk of reinjury, the risk of poor performance when returning to high-level sport activity is also a major concern among athletes. Amin et al investigated performance outcomes following complete Achilles tendon ruptures in National Basketball Association (NBA) players and found that of 18 players with this injury, 7 never returned to play professionally. Of the 11 that did, 8 only played 2 or more seasons professionally. Those players that returned also demonstrated significant declines in performance, as their Player Efficiency Rating (PER), an advanced metric commonly used in the sport to determine a player’s performance, was reduced by 4.57 in the first season and 4.38 in the second season upon returning to the court. [10] Parekh et al investigated a similar idea in the National Football League (NFL) and found similar results. Of 31 participants in the study who suffered a complete Achilles tendon rupture, 10 (32%) never competed professionally again. Power ratings in NFL players returning from this injury also declined with 78-88% and 64-95% reductions in offensive and defensive players, respectively. [11]

While the literature surrounding return to sport (RTS) guidelines is growing, most of the literature surrounds return to sport following an ACL injury rather than an Achilles injury. Some of the most common tools used to determine a patient’s readiness for sport include the Y-Balance Test, Ankle Hop Testing, Closed Kinetic Chain Dorsiflexion Test, and AlterG (an anti-gravity treadmill) Return to Running Program, which were used with the patient in this case study. Discussion continues surrounding evidence, or lack thereof, that these tools are reliable and effective in clinical decision making. The purpose of this case study is to investigate the utility of movement screens to assist in the

decision to clear an athlete to return to competitive soccer following an Achilles tendon repair.

Case Description

Patient History

The patient was a 23-year-old male who suffered a ruptured left Achilles tendon when trying to accelerate to a sprint while playing soccer. He underwent surgery to repair the Achilles within 1 week of injury. The patient was first evaluated by a physical therapist 5 weeks after surgery. He presented to the clinic wearing a controlled ankle motion (CAM) walking boot and crutches, as he was still non-weight bearing (NWB) at this time. He was able to take the boot off at times to perform active range of motion (AROM) ankle exercises provided to him by his surgeon. The patient denied a past medical history of lower extremity injuries. He was also in excellent general health and had no other co-morbidities. Prior to injury, the patient was an active soccer player, runner and weightlifter. He had the long-term goal of returning to soccer in one year.

Examination

For the initial examination, the patient reported low pain levels, ranging from 0-3/10 on the Numeric Rating Scale. The patient completed a Patient Specific Functional Scale (PSFS) in which patients pick 3 specific activities that are important to them to rate from 0-10/10; with 10 meaning they are able to complete the activity with no pain or difficulty [23]. The patient rated himself as 2/10 for walking, 2/10 for standing, and 3/10 for ankle mobility. He also completed a survey, Focus on Therapeutic Outcomes (FOTO), which is a self-reported outcome measure that takes both physical and psychological aspects into account. FOTO is rated on a scale of 0-100/100, with a higher score representing lower disability levels. He scored 31/100 on this measure during initial evaluation.

The patient demonstrated significantly decreased ankle range of motion (ROM) as shown in Table 1 below when measured with a hand-held goniometer, which has been shown to have a moderate rating in terms of intrarater reliability, or a single person taking the same measurement but a poor rating in terms of interrater reliability, or multiple people taking the same measurement. [12,13] Strength was not tested on the injured side at evaluation, as he was not safe for active resisted motion of the ankle at this time. Right ankle strength was 5/5 in all planes of motion and he was able to perform 25 consecutive heel raises on the right limb. Another test of ankle motion that was used with this patient was the closed kinetic chain (CKC) dorsiflexion test. CKC means that motion occurs about a fixed point on the ground, such as during a squat, rather than moving an elevated limb through the air (open kinetic chain), such as during a kick of a ball. This test is performed one leg at a time by having the patient place their big toe 10cm away from the wall and attempting to touch the knee to the wall without lifting the heel from the ground. Again, this was left untested on the injured side during initial evaluation, but he passed the test on the healthy side. Konor et al found that using this tape measure method was reliable for novice raters (within-session intrarater reliability: 0.98-0.99). [14]

Table 1. Initial Evaluation ROM Values

Ankle ROM	Right	Left (injured)
Dorsiflexion	14°	-9°
Plantar flexion	50°	39°
Inversion	42°	18°
Eversion	22°	13°
Calf flexibility in long sitting	10°	-25°

Progress Note 1

Up to this point, the patient had been working on improving his range of motion, strength and neuromuscular control in a controlled environment with an emphasis on ankle strength and mobility as well as proximal hip strengthening, with only recent introductions into more dynamic tasks such as light plyometric activities and higher-level dynamic balance tasks. His updated ROM measurements are in Table 2 below. Strength was rated as 5/5 for all ankle movements bilaterally, 25/25 consecutive heel raises on the right but only 15/25 on the left. He was also able to demonstrate good balance, as he could stand on each leg for 30 seconds with eyes closed. However, he was unable to complete the CKC dorsiflexion test on the L at this time. In terms of subjective progress, the patient rated himself at 9/10 for walking, 10/10 for standing and 10/10 for ankle mobility on the PSFS and scored a 64/100 on the FOTO outcome measure, both representing considerable improvements from the initial evaluation.

Table 2. Progress Note 1 ROM Values

Ankle ROM	Right	Left (injured)
Dorsiflexion	14°	17°
Plantar flexion	50°	30°
Inversion	42°	35°
Eversion	22°	32°
Calf flexibility in long sitting	10°	12°

Approximately 13 weeks after the initial evaluation, the patient was deemed ready to perform the first of his RTS tests, the Y-Balance Test (YBT). The YBT is a test that assesses a person's performance of a single-leg balance task while performing a reaching task with the other leg in anterior, posteromedial and posterolateral directions. [15,16] Figure 1 below illustrates the YBT more clearly. In order to pass this test, the patient must perform within 4cm of their healthy limb with their injured limb in all directions, though these cutoffs have poor specificity and sensitivity. [16] To prevent patients from negatively biasing their distances on their healthy limb to ensure that laterality is similar, they must also score 90% or better on both right and left composites, which compare the patient's distances in each direction to their limb length, represented as a percentage. This patient's results are in Table 3 below. As you can see, he actually did perform better with his injured leg than with his healthy leg, but composite scores were both above 90%, good enough for passing.

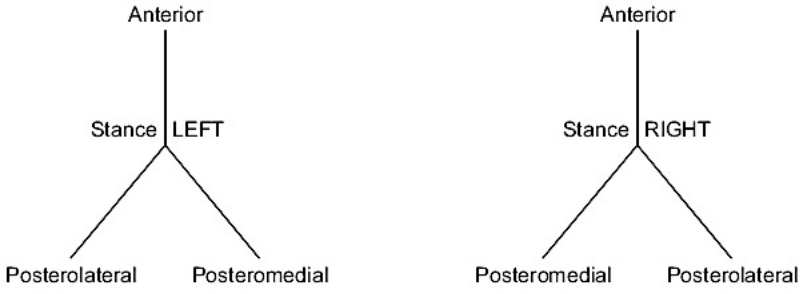

Figure 1. Y-Balance Test Diagram adapted from [17]

Table 3. Y-Balance Test results.

Direction	Right Stance (cm)	Left Stance (cm)	Difference
Anterior	61	62	**-1**
Posteromedial	95	95	**0**
Posterolateral	99	105	**-6**
Composite Score	**90%**	**93%**	

Limb length = 94 cm bilaterally

Return to Running

Based on his passing of the YBT and ability to tolerate strengthening and introductory plyometric exercises, he was deemed ready to begin partial weight bearing (PWB) running in this clinic's anti-gravity treadmill, the AlterG treadmill. The AlterG is a treadmill that allows for finely tuned adjustments of weight bearing, or gravity, on the lower extremities. The patient uses a special pair of shorts that zip into an air chamber that surrounds the treadmill, which then inflates to calibrate with each patient's body weight. After calibration, clinicians can then "alter the gravity" that the patient will run with on the treadmill, allowing for a great way to slowly and safely return to regular running. The gravity progression used is as follows: 60%, 70%, 80% body weight, all at 10 minutes. Then, 85%, 90%, 95%, 100% body weight, all at 15 minutes. Finally, a 15-minute run on a regular treadmill is performed. The patient may move from one stage to the next once they have completed a given stage without symptoms. Once they complete the 8th stage of a 15-minute run on a regular treadmill, they were cleared to run outdoors without restrictions. Early research shows that patients that use the anti-gravity (AG) treadmill are not significantly different from controls that have similar surgeries or rehabilitation protocols (AG: outside running at 18.1$\pm$3.9 weeks vs. control: outside running at 20.1$\pm$4.1 weeks). Saxena et al found that being able to run symptom-free at 85% of body weight after surgery was enough to clear patients for outside running. [18]

Progress Note 2

Another progress note was completed approximately 6 weeks later to evaluate the patient's progress and need for further skilled therapy. During this time, the patient's strengthening and plyometric exercises had increased in volume and difficulty. He had also begun to perform soccer-specific and ankle-specific agility and hop drills. At this point, the patient subjectively felt great, with PSFS scores of 10/10 on all three activities: walking, standing and ankle mobility, and a FOTO score of 99/100. The patient completed the same CKC dorsiflexion test, but again failed on the left. He also performed a single leg squat bilaterally to check for compensatory patterns, but he performed them with excellent mechanics and no compensation on either leg.

This patient began the return to running program approximately 16 weeks after initial evaluation and completed it without setbacks within the next 6 weeks, where he was then cleared to begin running outdoors on uneven surfaces. Initially he had reported some difficulty with outdoor running as he still did not demonstrate equal functional strength and power on the left as he did on the right, which was evident during performance of single leg plyometric exercises, despite 5/5 scores on all ankle manual muscle tests (MMT). Again, he performed 25/25 consecutive heel raises on the right leg but only 22/25 on the left. The patient's updated ROM measurements are located in Table 4 below.

Table 4. Progress Note 2 ROM Values

Ankle ROM	Right	Left (injured)
Dorsiflexion	14°	11°
Plantar flexion	50°	35°
Inversion	42°	35°
Eversion	22°	32°
Calf flexibility in long sitting	10°	12°

Hop Testing

As stated above, the patient performed several single-leg hop drills at this point in the rehab process, first as an assessment for sport readiness, then as further plyometrics to improve dynamic load tolerance. The 4 hop tests (see Figure 2) that were used with this patient were as follows: Figure-of-Eight Hop Test (excellent reliability: intraclass correlation coefficient (ICC) of 0.95; minimal detectable change (MDC) of 4.59 sec), in which the patient would hop on one leg in a figure 8 pattern twice around two cones that were placed 5 meters apart as quickly as possible; Side Hop Test (good reliability: ICC of 0.84; MDC of 5.82 sec), in which the patient would hop on one leg laterally over a 30-cm distance for 10 repetitions as quickly as possible; 6-Meter Crossover Hop Test (excellent reliability: ICC of 0.96; MDC of 1.03 sec), in which the patient would hop diagonally over a 15-cm wide line, alternating sides for the 6 meter distance as quickly as possible; and the Square Hop Test (good reliability: ICC of 0.90; MDC of 3.88 sec), in which the patient would hop in and out of a 40x40 cm square for 5 repetitions as quickly as possible, starting outside of the square and hopping in, then out. Patients are to hop in a clockwise direction with the right limb and counterclockwise with the left limb. [19,20]

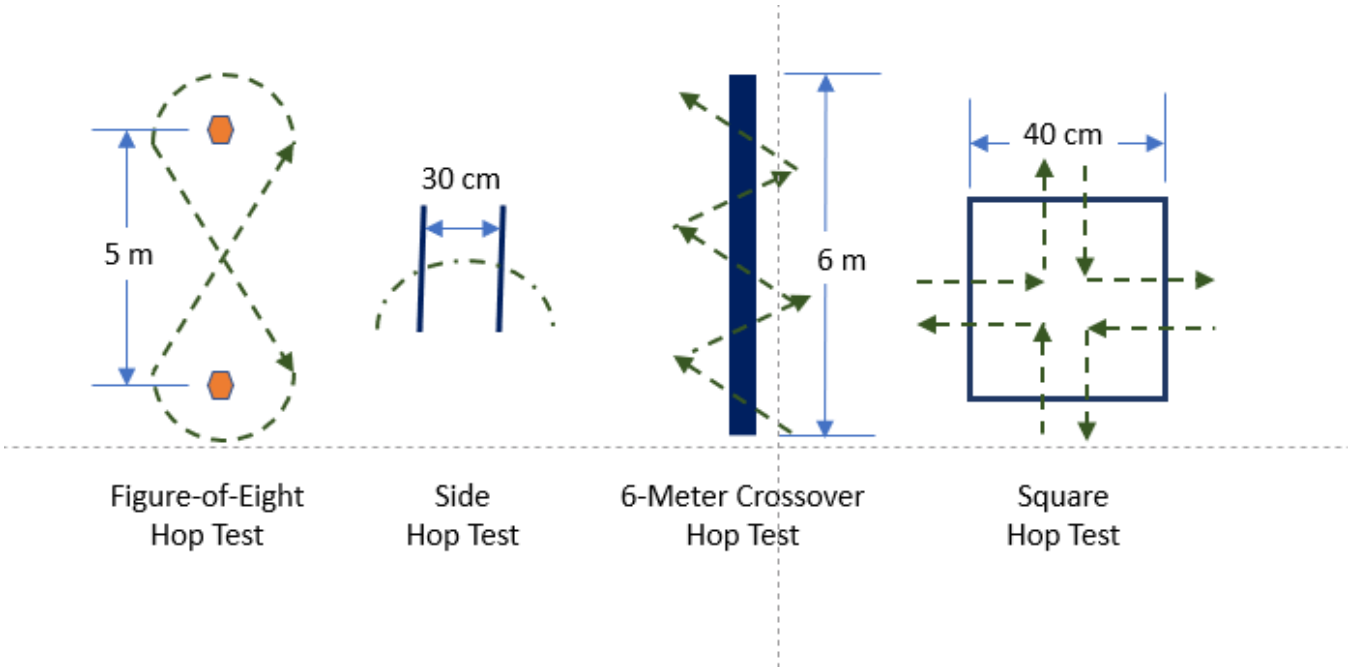

Figure 2. Schematic diagram of four ankle hop tests, adapted from [22].

Discharge from Physical Therapy

Approximately 2 weeks following the last progress note, he was discharged from physical therapy as his surgeon deemed him appropriate for discharge. He had met most of his rehab goals except for returning to his prior level of participation in soccer by 16-20 weeks. He had progressed to performing and tolerating soccer ball handling and kicking drills, all while continuing to develop strength and power of the gastrocsoleus complex. Unfortunately, he still demonstrated decreased functional strength and power on his injured limb compared to the healthy limb that was evident during the performance of plyometric exercises in which rapid power development was critical.

The patient performed all of his special tests over again for discharge. He was able to perform a single leg squat bilaterally with good mechanics and appropriate depth. Again, he failed the CKC dorsiflexion test on his left leg but passed it on the right. A single-leg balance test with eyes closed was performed again, and the patient passed each, being able to stand on each leg for 30 seconds. In Table 5 below, the patient's final ROM measurements are listed.

Table 5. Discharge ROM Values

Ankle ROM	Right	Left (injured)
Dorsiflexion	14°	11°
Plantar flexion	50°	38°
Inversion	42°	45°
Eversion	22°	32°
Calf flexibility in long sitting	10°	13°

Discussion

The purpose of this case study is to investigate the utility of movement screens to assist in the decision-making process, along with a clinician's judgment, to clear an athlete to safely return to sport and minimize risk of reinjury following an Achilles tendon repair. Treatment sessions were used initially to regain weight bearing tolerance, range of motion and strength. Eventually, treatment progressed to incorporate exercises and tasks that reproduce the dynamic nature of running and playing soccer, as it was a major goal for the patient to return to these activities regularly and safely. Thus, repeatable, dynamic, single-leg control became a crucial component of care. Observation of a single-leg squat is a common practice for physical therapists, but it is subjective in nature and the novice eye cannot capture every detail of the movement. Therefore, using objective measures to either confirm or make you question what you observe are important, especially in a clinician's early years.

The Y-Balance Test, Ankle Hop Tests, CKC dorsiflexion test and AlterG Return to Running Programs are clinician-friendly tests/protocols that can be used to assist in the determination of an athlete's readiness to return to sport. These tests allow the patient to mimic some of the movements in their sport in a safe, controlled environment, making them appropriate for determination of sport readiness. Seeing objective data that shows equal or close-to-equal performance between injured and healthy limbs could also provide a positive psychological impact for those patients who are unsure if they are ready to return to sport or have a degree of kinesiophobia. Fear of reinjury often impacts RTS decision-making after Achilles rupture, especially when returning to the sport that the injury occurred in. [24] Future studies should look into the impact that this objective data has on a rehabilitating patient's confidence levels with movement.

Current literature has begun to look at the RTS process as a continuum, from Return to Participation, to Return to Sport, to Return to Performance. In the first phase, the athlete may be rehabilitating, so he or she is physically active but unable (medically, physically, or psychologically) to return to sport. In the second phase, the athlete has returned to his or her sport, but is not yet back to their desired performance level. In the final phase, return to performance, the athlete has returned to his or her previous level or is exceeding this level. [21] Specific RTS criteria following Achilles tendon rupture is currently time-based, with the criteria being 16 and 20 weeks following injury prior to resuming non-contact and contact sport activity, respectively. [21]

While the patient's return to running was successful, it is unknown whether his return to playing soccer has had the same level of success, both in terms of being injury-free and having the same physical abilities on the playing field. Similarly, it is unknown what impact the objective measures with the given RTS tests had on his success or lack thereof once he returned to sport. From the date of surgery until discharge, 183 days had passed. Assuming that he is well-represented by subjects in the Maffulli et al study that looked at early vs. late return to professional soccer in the UEFA Champions League in Europe, and that he did not play soccer on the day of discharge, we can presume that he had a higher likelihood of returning safely to soccer as the cutoff was 161 ± 65 days off following Achilles rupture. [9] One study by Olsson et al looked at long-term function following an acute Achilles tendon rupture. They found that major deficits, in terms of symptoms, function and physical activity levels, persist 2 years post-operatively and that only minor improvements are seen between the 1- and 2-year marks, despite their subjectively reported outcomes improving. The authors believed this was due to patients adjusting to their impairments, or "accepting a new normal" and therefore the focus should be on improving the patient as much as possible within the first year following repair. [22]

This case is not without limitations, as no single test can provide enough insight to adequately predict a safe and effective return to sport. As this case study has illustrated, many of these tests are flawed with poor to moderate data supporting their use. [15,16,18] There are also several other tests available that were not used with this specific patient due to limited availability at this clinical site, including the Functional Movement Screen (FMS) or Tuck Jump Assessment. Even using multiple tests such as these presented in this case study and those that weren't comes with limitations, including cost of all testing equipment and time for a clinician to perform each test. The FOTO outcome measure that was used with this patient has questions that assess a patient's kinesiophobia, and had the patient not scored so well on this outcome measure, it would have been in best practice to further assess his degree of kinesiophobia and other psychological variables due to the traumatic nature of his injury and long rehabilitation process. These objective tests should be used in conjunction with a clinician's professional judgment to provide the best advice to the patient regarding their individual RTS.

The best agreed upon strategy for RTS decisions at this time is to use a combination of things to determine an athlete's readiness to return. Not only should it be a combination of people (patient, surgeon, physical therapist, coaches and family) making the decision, but it should also include a combination of assessments (physical, psychological and social) to make a final determination. [21] Future research should focus on determining which combination is best able to predict a safe and successful RTS to maximize positive outcomes, perhaps by creating an algorithm that is able to account for all of these factors to help athletes understand their readiness level for their given sport.

References

1. Kvist M. Achilles Tendon Injuries in Athletes. Sports Medicine (1994) 18: 173.
2. Moller A, Astron M, Westlin N. Increasing incidence of Achilles tendon rupture. Acta Orthop Scand. 1996;67(5):479-481.
3. Leppilahti J, Puranen J, Orava S. Incidence of Achilles Tendon Rupture. Acta Orthop Scand. 1996;67(3):277-279.
4. Houshian S, Tscherning T, Riegels-Nielsen P. The epidemiology of Achilles tendon rupture in a Danish county. Injury. 1998;29(9):651-654.
5. Suchak AA, Bostick G, Reid D, Blitz S, Jomha N. The incidence of Achilles tendon rupture in Edmonton, Canada. Foot Ankle Int. 2005 Nov;26(11):932-6.
6. Raikin S, Garras D, Krapchev P. Achilles Tendon Injuries in a United States Population. Foot Ankle Int. 2013;34(4):475-480.
7. Gwynne-Jones D, Sims M, Handcock D. Epidemiology and Outcomes of Acute Achilles Tendon Rupture with Operative or Nonoperative Treatment Using an Identical Functional Bracing Protocol. Foot Ankle Int. 2011 Apr;32(4):337-43.
8. Soldatis JJ, Goodfellow DB, Wilber JH. End-to-end operative repair of Achilles tendon rupture. Am J Sports Med. 1997;25(1):90-95.
9. Gajhede-Knudsen M, Ekstrand J, Magnusson H, Maffulli N. Recurrence of Achilles tendon injuries in elite male football players is more common after early return to play: an 11-year follow-up of the UEFA Champions League injury study. Br J Sports Med. 2013 Aug;47(12):763-8.
10. Amin NH, Old AB, Tabb LP, Garg R, Toossi N, Cerynik DL. Performance Outcomes After Repair of Complete Achilles Tendon Ruptures in National Basketball Association Players. Am J Sports Med. 2013 Aug;41(8):`864-8.
11. Parekh S, Wray W, Brimmo O, Sennett B, Wapner K. Epidemiology and Outcomes of Achilles Tendon Ruptures in the National Football League. Foot Ankle Spec. 2009 Dec;2(6):283-6.
12. Jung IG, Yu IY, Kim SY, Lee DK, Oh JS. Reliability of ankle dorsiflexion passive range of motion measurements obtained using a hand-held goniometer and Biodex dynamometer in stroke patients. J Phys Ther Sci. 2015 Jun;27(6):1899-1901.
13. Kim PJ, Peace R, Mieras J, Thoms T, Freeman D, Page J. Interrater and intrarater reliability in the measurement of ankle joint dorsiflexion is independent of examiner experience and technique used. J Am Podiatr Med Assoc. 2011 Sep-Oct;101(5):407-14.
14. Konor MM, Morton S, Eckerson JM, Grindstaff TL. Reliability of Three Measures of Ankle Dorsiflexion Range of Motion. Int J Sports Phys Ther. 2012 Jun;7(3):279-87.
15. Smith CA, Chimera NJ, Warren M. Association of y balance test reach asymmetry and injury in division I athletes. Med Sci Sports Exerc. 2015 Jan;47(1):136-41.
16. Lai WC, Wang D, Chen JB, Vail J, Rugg CM, Hame SL. Lower Quarter Y-Balance Test Scores and Lower Extremity Injury in NCAA Division I Athletes. Orthop J Sports Med. 2017 Aug 8;5(8):2325967117723666.
17. Sarshin, Amir & Mohammadi, Sardar & Babaei, Hossein & Shahrabad, Pour & Sedighi, Mahboobeh. The effects of functional fatigue on dynamic postural control of badminton players. Biol Exerc. 2011. 7. 10.4127/jbe.2011.0047.
18. Saxena A, Granot A. Use of an Anti-gravity Treadmill in the Rehabilitation of the Operated Achilles Tendon: A Pilot Study. J Foot Ankle Surg. 2011 Sep-Oct;50(5):558-61.
19. Caffrey E, Docherty C, Schrader J, Klossner J. The Ability of 4 Single-Limb Hopping Tests to Detect Functional Performance Deficits in Individuals With Functional Ankle Instability. J Orthop Sports Phys Ther. 2009 Nov;39(11):799-806.

20. Sharma N, Sharma A, Singh Sandhu J. Functional Performance Testing in Athletes with Functional Ankle Instability. Asian J Sports Med. 2011 Dec;2(4):249-58.
21. Ardern CL, Glasgow P, Schneiders A, Witvrouw E, et al. 2016 Consensus Statement on Return to Sport from the First World Congress in Sports Physical Therapy, Bern. Br J Sports Med. 2016 Jul;50(14):853-64.
22. Olsson N, Nilsson-Helander K, Karlsson J, Eriksson BI, Thomée R, Faxén E, Silbernagel KG. Major functional deficits persist 2 years after acute Achilles tendon rupture. Knee Surg Sports Traumatol Arthrosc. 2011 Aug;19(8):1385-93.
23. Stratford, P., Gill, C., Westaway, M., & Binkley, J. (1995). Assessing disability and change on individual patients: a report of a patient specific measure. Physiotherapy Canada, 47, 258-263.

