[Sports Physical Therapy]

CEU

Return to Play in Athletes Following Ankle Injuries

Thomas O. Clanton, MD, Lauren M. Matheny, BA,*
Hannah C. Jarvis, MB, BS, AICSM, BSc(Hons), MRCS (Eng), and Anastasia B. Jeronimus, PT, DPT, OCS

Background: The decision to return to play following an ankle injury is a multifactorial process involving both physical and psychological parameters. The current body of literature lacks evidence-based guidelines to assist in the decision.

Objective: This article reviews the evidence to support such testing: the dorsiflexion lunge test, star excursion balance test, agility T-test, and sargent/vertical jump test. The importance of psychological factors is also highlighted.

Evidence Acquisition: The primary literature search was conducted using PubMed (http://www.ncbi.nlm.nih.gov/pubmed/) with the search terms "ankle AND injury" and the following limits activated: English language. A secondary search was then conducted with the search terms "return to play" and "sport injuries and return to play."

Results: Various functional tests have been used to determine whether a patient is able to return to play following an ankle injury. This study documented four tests that have been used to assess range of motion, balance and proprioception, agility and strength and the reasoning as to why these tests are used.

Conclusions: Functional testing provides objective measures for gauging an athlete's progression through the rehabilitation process. Testing balance and proprioception, strength, range of motion, and agility coupled with psychological assessment evaluates readiness for return to play.

Keywords: return to play; ankle injuries; athletes; functional testing; team physician

The duties of the team physician are to "coordinate rehabilitation and return to participation, and to provide for proper preparation for safe return to participation after an illness or injury."[36] There can often be immense pressure on a physician to clear an athlete to play, posing great challenges.[35]

A decision-based model was developed by Creighton et al,[6] and it aims to build on the basic elements of the return-to-play (RTP) process and includes many factors that can influence each stage. The first step is evaluation of the athlete's health status, which is evaluated by functional testing. The second step is determining participation risk, which is dictated by the type of sport. The third step involves decision modification and is affected by factors such as pressure from the athlete.[6]

In general, if an athlete has sustained a previous injury, the reinjury risk is increased fourfold.[6] Despite this, athletes are likely to RTP as quickly as possible. Most existing research involving RTP decisions has been based on serious conditions, such as concussion, spinal cord injury, or cardiac anomalies.[6]

There is a lack of evidence-based medicine, especially related to the foot and ankle, to assist in the decision to allow an athlete to RTP. This can lead to disagreement, confusion, and a poor decision.[18] Unfortunately, the priorities of the team can conflict with that of the athlete. The athlete may wish to continue to play despite an injury.[8]

ANKLE INJURIES AND RTP

The ankle is the most common site of injury in 24 of 70 sports.[10] Ankle sprain accounted for 76.7% of injuries, followed by fractures at 16.3%. Basketball and soccer have a higher proportion of ankle injuries.[10] In soccer, the risk of injury during match play is 4 to 6 times greater than during training.[17]

Once an ankle sprain occurs, up to 80% will suffer recurrent sprains, and up to 72% develop recurrent symptoms or chronic instability.[21] Basketball athletes are 5 times more likely to injure an ankle after a prior ankle injury, with a recurrence rate of

From the Steadman Philippon Research Institute, Vail, Colorado.
*Address correspondence to Lauren M. Matheny, Lower Extremity Research Coordinator, Steadman Philippon Research Institute, Center for Outcomes-Based Orthopaedic Research, 181 West Meadow Drive, Suite 1000, Vail, CO 81657 (e-mail: lauren.matheny@sprivail.org).
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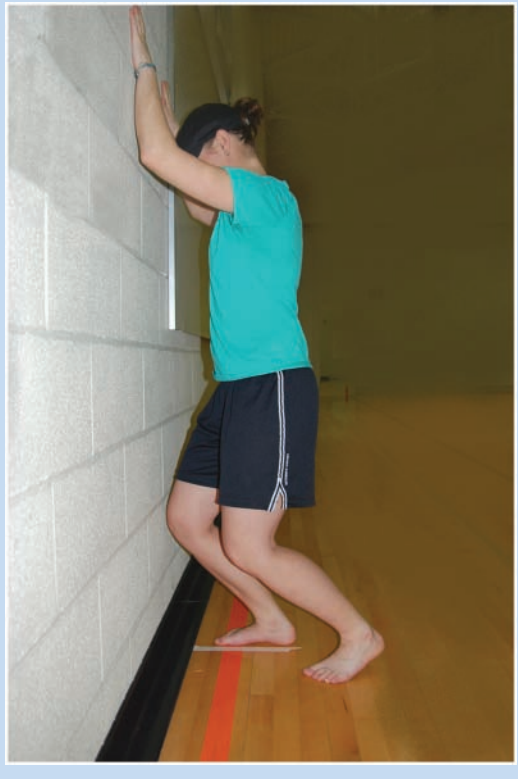

Figure 1. The dorsiflexion lunge test to evaluate range of motion.

73%.[28,29] Recurrence most strongly correlates with premature return to sport and a prior ankle injury.[23]

In determining an athlete's ability to RTP, subjective and objective data are required in a quantitative and qualitative way. The lack of evidence-based guidelines for clearing an athlete to RTP with ankle injuries makes this determination very challenging. Although various foot and ankle scoring systems exist, none have been validated for RTP decisions. None can confidently determine the critical point at which RTP would be acceptable.

The World Health Organization promotes assessment of health and disability in terms of function.[41] Each test should relate to the activities involved in competitive play. These assess pain, instability, kinematics, and symmetry.[6] These tests can determine balance, coordination, and multiplanar muscular stabilization with loads across the ankle joint and inversion.[42]

FUNCTIONAL TESTING

Range of Motion: The Dorsiflexion Lunge Test

Dorsiflexion is necessary for a normal gait, climbing stairs, and rising from a squatting position. Patients lacking adequate dorsiflexion are at increased risk for reinjury and have limitations in normal functional activities.[39]

The dorsiflexion lunge test is a weightbearing test performed by placing the foot perpendicular to a wall and lunging the knee toward the wall. The foot is sequentially moved farther away from the wall until the maximum range of dorsiflexion is achieved. The heel should not be lifted off from the floor, and the subtalar joint should be locked (Figure 1). The distance from the foot to the wall is measured; less than 9 to 10 cm is considered restricted.[4,30] Also, the angle of the tibial shaft in reference to the wall is measured; less than 35° to 38° is restricted.[4,30] The intra- and interrater reliability of this test has been confirmed.[4] This test is predictive of future injury in cricket and soccer.[4,7,11,30]

To compensate for dorsiflexion stiffness, athletes may demonstrate exaggerated hip flexion and inhibited knee flexion, and the foot may rise from the floor. In assessing treatment, weightbearing measures are more likely than nonweightbearing measures to detect treatment effects.[40]

Balance and Proprioception: The Star Excursion Balance Test

There is conflicting evidence of proprioceptive defects in chronic ankle instability.[16,22,31] Balance is a crucial element of most sports; loss of proprioception is a risk factor for reinjury.[26,28,37] It can be assessed with noninstrumented and instrumented techniques of varying duration, with and without vision/shoes, and with or without the use of hands.[31]

The star excursion balance test (SEBT) determines unilateral balance and dynamic neuromuscular control; it requires strength, flexibility, and proprioception.[29] It also requires a base of support on 1 leg while reaching maximally in defined directions with the contralateral leg, forming an 8-point star shape.[13] The Y Balance Test (Functional Movement Systems, Danville, Virginia) is an instrumented version of the SEBT. It tests only the anterior, posteromedial, and posterolateral components of the SEBT. The posteromedial component is the most representative of overall performance on the original 8 components (Figure 2).[14] The SEBT has excellent intraobserver reliability[19] and is sensitive for ankle instability.[27] The SEBT is a predictive measure of lower extremity injury in high school basketball players.[29]

Agility: Agility T-Test

Agility is the ability to change direction rapidly; a more comprehensive description includes physical demand, cognitive processes, and technical skills.[34] It is an essential component of team and field sports for a variety of reasons: neuromuscular control, injury reduction, and overall performance capabilities.[38] Ankle injury often impairs agility in comparison to uninjured ankles.[21] In selecting an agility test, the movement skills required will vary between sports and position played.[38]

The agility T-test measures movement in multiple directions. The athlete must navigate a T-shaped course; the horizontal and longitudinal arms are 10 yd each. The athlete sprints from the base of the longitudinal arm to the center of the horizontal arm. Then, facing forward, he or she sidesteps to one end of the horizontal arm without crossing feet and continues to the other end. To finish, they sidestep back to the center of the horizontal arm and run backward down the longitudinal limb to the starting

Figure 2. The star excursion balance test to evaluate balance and proprioception.

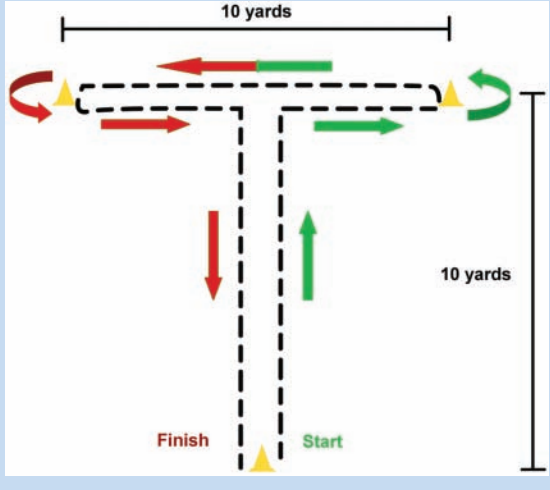

Figure 3. The agility T-test to evaluate agility.

point (Figure 3). Typical times for athletic adults are between 8.9 to 13.5 seconds[33]; high reliability has been demonstrated.[25]

Strength: Sargent/Vertical Jump Test

Athletes that demonstrate deficits in strength and flexibility are more prone to lower extremity injuries[20]; neuromuscular training programs can prevent injuries.[15] Athletes with muscle strength imbalance are at an increased risk of ankle injuries.[3]

The sargent jump test (Figure 4) evaluates strength, speed, energy, and dexterity and estimates power jumps. The athlete squats and jumps upward into full extension, reaching for a cardboard disk above. The distance jumped is measured:

efficiency index = weight (lb) × jump (in) / height (in).[32]

The sargent jump test is a reliable test for the estimation of explosive power of the lower limb.[1,24]

Figure 4. Sargent/vertical jump test to evaluate strength.

PSYCHOLOGICAL FACTORS

Between 5% and 19% of athletes experience psychological distress following an injury to levels comparable with patients receiving treatment for mental health illness.[12] Stress increases the risk of an athletic injury.[9,12] Rehabilitation following injury can be adversely affected by loss of confidence, fear, and anxiety. Most of these reactions are transient and improve during the rehabilitation process.[9] An athlete should demonstrate psychosocial readiness prior to RTP.[2] Athletes who demonstrate apprehension, fear, or anxiety are at a much greater risk of reinjury, and there is often a deleterious effect on athletic performance.[2,9] Scoring systems can formally assess this component: Trait Sport Confidence Inventory,[9]

State Sport Confidence Inventory,[9] and the Injury-Psychological Readiness to Return to Sport Scale.[9]

CONCLUSION

The decision to RTP following an ankle injury is a multifactorial process. Functional testing provides objective measures to gauge an athlete's progression through the rehabilitation process. Testing balance, proprioception, strength, range of motion, and agility assess physical readiness. Coupled with psychological assessment, RTP decisions can be safely made.

REFERENCES

1. Adams GA. *Exercise Physiology Laboratory Manual.* 1994. Dubuque, IA: Brown & Benchmark.
2. American College of Sports Medicine, American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine. Psychological issues related to injury in athletes and the team physician: a consensus statement. *Med Sci Sports Exerc.* 2006;38:2030-2034.
3. Baumhauer JF, Alosa DM, Renström PAFH, Trevino S, Beynnon B. A prospective study of ankle injury risk factors. *Am J Sports Med.* 1995;23:564-570.
4. Bennell K, Talbot R, Wajswelner H, Techovanich W, Kelly D. Intra-rater and inter-rater reliability of a weight-bearing lunge measure of ankle dorsiflexion. *Aust J Physiother.* 1998;44:175-180.
5. Creighton DW, Shrier I, Shultz R, Meeuwisse WH, Matheson GO. Return-to-play in sport: a decision-based model. *Clin J Sport Med.* 2010;20: 379-385.
6. Dennis RJ, Finch CF, McIntosh AS, Elliott BC. Use of field-based tests to identify risk factors for injury to fast bowlers in cricket. *Br J Sports Med.* 1998;42:477-482.
7. Dunn WR, George MS, Churchill L, Spindler KP. Ethics in sports medicine. *Am J Sports Med.* 2007;35:840-844.
8. Evans L, Hardy L, Fleiming S. Intervention strategies with injured athletes: an action research study. *Sport Psychol.* 2000;14:188-206.
9. Fong DTP, Hong Y, Chan LK, Yung SH, Chan KM. A systematic review on ankle injury and ankle sprain in sports. *Sports Med.* 2007;37:73-94.
10. Gabbe BJ, Finch CF, Wajswelner H, Bennell KL. Predictors of lower extremity injuries at the community level of Australian football. *Clin J Sport Med.* 2004;14:56-63.
11. Glazer DD. Development and preliminary validation of the Injury Psychological Readiness to Return to Sport (I-PRRS) Scale. *J Athl Train.* 2009;44:185-189.
12. Gribble PA, Hertel J. Considerations for normalizing measures of the star excursion balance test. *Meas Phys Educ Exerc Sci.* 2003;7:89-100.
13. Hertel J, Braham RA, Hale SA, Olmsted-Kramer LC. Simplifying the star excursion balance test: analyses with and without chronic ankle instability. *J Orthop Sports Phys Ther.* 2006;36:131-137.
14. Hewett TE, Lindenfeld TN, Riccobene JV, Noyes FR. The effect of neuromuscular training on the incidence of knee injury in female athletes: a prospective study. *Am J Sports Med.* 1999;27:699-706.
15 Isakov E, Mizrahi J. Is balance impaired by recurrent sprained ankle? *Br J Sports Med.* 1997;31:65-67.
16. Junge A, Dvorak J. Soccer injuries: a review on incidence and prevention. *Sports Med.* 2004;34:929-938.
17. Kane SM, White RA. Medical malpractice and the sports medicine clinician. *Clin Orthop Relat Res.* 2009;467:412-419.
18. Kinzey S, Armstrong C. The reliability of the star-excursion balance test in assessing dynamic balance. *J Orthop Sports Phys Ther.* 1998;27:356-360.
19. Knapik JJ, Bauman CL, Jones BH, Harris JM, Vaughan L. Preseason strength and flexibility imbalances associated with athletic injuries in female collegiate athletes. *Am J Sports Med.* 1991;19:76-81.
20. Larmer PJ. *An Investigation Into Patient Perceptions and Performance of Physical Tasks Following Acute Ankle Sprains Using a Mixed Methods Approach* [DHSc thesis]. Auckland, New Zealand; Auckland University of Technology; 2009.
21. Lentell G, Katzmann LL, Walters MR. The relationship between muscle function and ankle stability. *J Orthop Sports Phys Ther.* 1990;11:605-611.
22. Malliaropoulos N, Ntessalen M, Papacostas E, Longo UG, Maffulli N. Reinjury after acute lateral ankle sprains in elite track and field athletes. *Am J Sports Med.* 2009;37:1755-1761.
23 Markovic G, Dizdar D, Jukic I, Cardinale M. Reliability and factorial validity of squat and countermovement jump tests. *J Strength Cond Res.* 2004;18:551-555.
24. Munro AG, Herrington LC. Between-session reliability of four hop tests and the agility T-test. *J Strength Cond Res.* 2011;25:1470-1477.
25. Nichols DS, Glenn TM, Hutchinson KJ. Changes in the mean center of balance during balance testing in young adults. *Physical Therapy.* 1995;75:699-706.
26. Olmsted LC, Carcia CR, Hertel J, Shultz SJ. Efficacy of the star excursion balance tests in detecting reach deficits in subjects with chronic ankle instability. *J Athl Train.* 2002;37:501-506.
27. Payne KA, Berg K, Latin RW. Ankle injuries and ankle strength, flexibility, and proprioception in college basketball players. *J Athl Train.* 1997;32:221-225.
28. Plisky PJ, Rauh MJ, Kaminski TW, Underwood FB. Star excursion balance test as a predictor of lower extremity injury in high school basketball players. *J Orthop Sports Phys Ther.* 2006;36:911-919.
29. Pope R, Herbert R, Kirwan J. Effects of ankle dorsiflexion range and pre-exercise calf muscle stretching on injury risk in Army recruits. *Aust J Physiother.* 1998;44:165-172.
30. Ross SE, Guskiewicz KM, Gross MT, Yu B. Balance measures for discriminating between functionally unstable and stable ankles. *Med Sci Sports Exerc.* 2009;41:399-407.
31. Sargent DA. The physical test of a man. *American Physical Education Review.* 1921;26:188-194.
32. Semenick D. Testing protocols and procedures. Page. In: Baechle TR, Earle RW, eds. *Essentials of Strength Training and Conditioning.* 3rd ed. Champaign, IL: Human Kinetics; 2008:264.
33. Sheppard JM, Young WB. Agility literature review: classifications, training and testing. *J Sports Sci.* 2006;24:919-932.
34. The team physician and return-to-play issues consensus statement. http://www.amssm.org/MemberFiles/RTP_Cons_State.pdf. Published 2002. Accessed September 2011.
35. The team physician: a consensus statement. From AMSSM website. http://www.amssm.org/MemberFiles/TPCStatement.pdf. Published 2000. Accessed September 2011
36. Trojian TH, McKeag DB. Single leg balance test to identify risk of ankle sprains. *Br J Sports Med.* 2006;40:610-613.
37. Vescovi JD. *Agility.* Colorado Springs, CO: National Strength and Conditioning Association; 2006.
38. Vincenzino B, Branjerdporn M, Teys P, Jordan K. Initial changes in posterior talar glide and dorsiflexion of the ankle after mobilization with movement in individuals with recurrent ankle sprain. *J Orthop Sports Phys Ther.* 2006;36:464-471.
39. Vincenzino B, Prangley I, Martin D. The initial effect of two Mulligan mobilization with movement treatment techniques on ankle dorsiflexion. In: *Proceedings of the Australian Conference of Science and Medicine in Sport,* Perth, WA, June 2001. Brisbane, Queensland, Australia: Sports Medicine Australia; 2001.
40. World Health Organization. Classifications: International Classification of Functioning, Disability and Health (ICF). 2001. http://www.who.int/classifications/icf/en/. Accessed September 2011.
41. Yildiz Y, Şekir U, Hazneci B, Örs F, Saka T, Aydin T. Reliability of a functional test battery evaluating functionality, proprioception and strength of the ankle joint. *Turk J Med Sci.* 2009;39:115-123.