Effects of Eccentric Exercise on Tendon Loading and Ankle Power During a Single-leg Heel Rise and Lowering Task

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Background

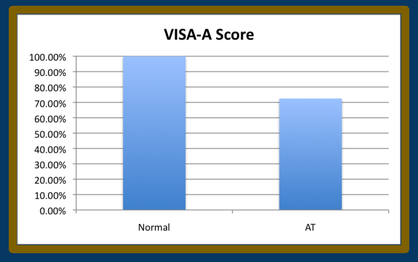
- Documented injury rates among recreational runners range between 25-65%.[1 2]
- Achilles tendon injuries are among the highest with the incidence in recreational and elite athletes ranging between 6-18%.[3]
- Chronic mid-portion Achilles tendinosis is characterized by pain, localized thickening, and results in degeneration of the tendon and changes in collagen.
- The challenge to is that a significant number of patients (29%) with Achilles tendinopathy do not respond to conservative treatment and require surgical interventions.[4]
- The current conservative treatment modality is an eccentric exercise program.[5 6 7] Eccentric loading has better outcomes in strength and pain compared to control groups. However only 12 of the 22 in the experimental group rated themselves as fully recovered after 1 year followup.[6]
- Although much of the literature favors eccentric exercises and suggests that eccentrics be an integral part of the conservative management, little is known about the mechanism behind this favorable effect.
- Current studies suggest that the benefits of eccentric exercises are due to microcirculatory changes around the tendon and tendon remodeling secondary to collagen changes.[8 9 10]
- Current research also suggests that tendons need high mechanical loading to promote the healing process.[11]
- Based on this information, it may be that one of the reasons nearly 50% of the patients do not fully recover is that physical therapists are not dosing appropriately (ie higher eccentric loads).

Purpose

1. Determine if participants can perform an eccentric single-leg lowering exercise at a dosage higher than their concentric maximum
2. Compare forces during unweighted running trial

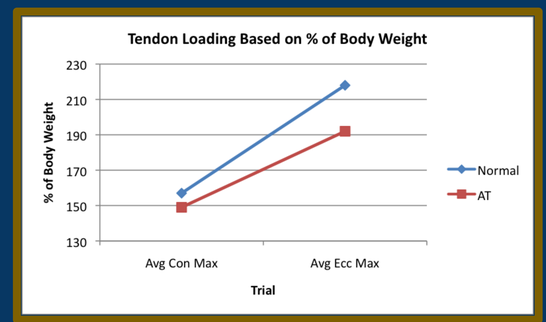
Methods

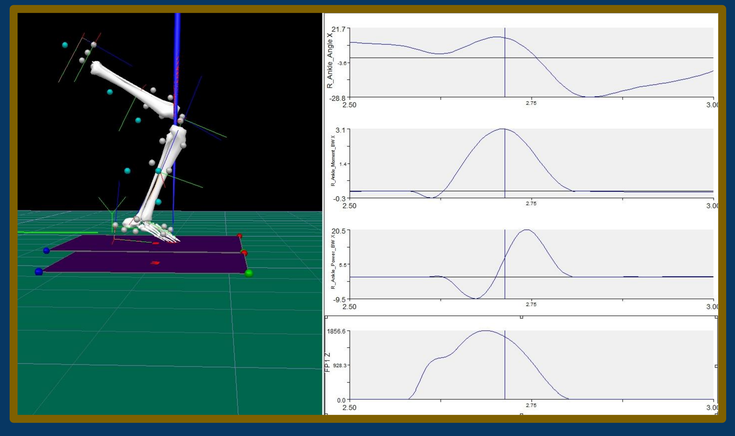
- 13 subjects, 9 healthy and 4 with Achilles tendinopathy were weighed at the beginning of their session. Subjects then completed the VISA-A form as well as a questionnaire regarding their activity and training habits. Subjects' ankle dorsiflexion was then measured by the bent knee wall test.
- Reflective markers were placed on key anatomical landmarks, the subjects were asked to perform one double limb calf raise on a 6cm block to assess their max plantarflexion range of motion.
- The subjects then had weighted vests placed on them to achieve 150% of their body weight and were instructed to perform a single leg calf raise. The opposite leg was then performed. If the subject was unable to achieve full range of motion the weight was reduced and the subject tried again. If the subject reported the trial felt too easy, more weight was added and the subject tried again.
- Once the subject's concentric max was reached, more weight was added to achieve 140% of their single leg concentric max weight. The subjects were then instructed to rise up with both feet, then to remove one, and attempt to eccentrically lower themselves in a controlled manner using only the remaining foot. Subjects were scored as either achieving a slow controlled motion, or not by the examiner watching their motions.
- If the subject was not able to eccentrically lower themselves their weight was reduced so that they had 125% of their concentric max, and the trial was completed using the same pass/fail scoring system.
- Subjects then removed the weight a performed three running trials on the force plate.

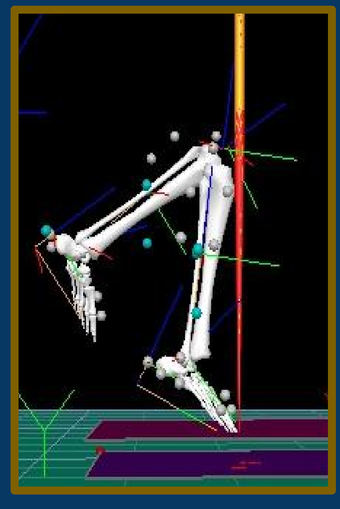


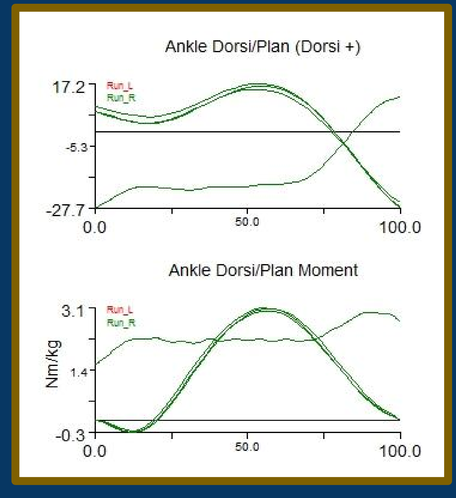
Results/Discussion

- Achilles tendinopathy group demonstrated 8% lower concentric max than normal group during single leg heel raise.
- More importantly Achilles group demonstrated 26% lower eccentric max than normal group during single leg lower task.
- Regardless of this difference, both groups were able to tolerate significantly greater tendon loads than in any previously known study.
  - Normal Group was able to concentrically lift 157% of body weight as well as eccentrically lift 218% of body weight
  - Achilles Tendinopathy Group was able to concentrically lift 149% of body weight as well as eccentrically lift 192% of body weight
- Peak moments around the ankle joint are similar between max single leg eccentric lowering task and unweighted running trial. `









References:

1. Macera C, Pate R, Powell K, et al. Predicting lower-extremity injuries among habitual runners. Arch Intern Med 1989; 149:2565-8
2. Van Mechelen W. Can running injuries be effectively prevented? Sports Med. 1995; 19:161-5.
3. Leach R, James S, Wasilewski S. Achilles review. Am J sports Med. 1981; 9:93-98
4. Paavola M, et al. Long-term prognosis of patients with Achilles tendinopathy. An observational 8-year follow-up study. Am J Sports Med. 2000; 28(5):634-42
5. Niesen-Vertommen SL, Taunton JE, Clement DB, Mosher RE. The effect of eccentric versus concentric exercise in the management of Achilles tendonitis. Clin J Sports Med. 1992; 2:109-113
6. Silbernagel KG, Thomee R, Thomee P, Karlsson J. Eccentric overload training for patients with chronic-Achilles tendon pain-a randomized controlled study with reliability testing of the evaluation methods. Scand J Med Sci Sports. 2001; 11(4):197-206.
7. Rompe JD, Nafe B, Furia JP, Maffulli N. Eccentric loading, shock-wave treatment, or a wait-and-see policy for tendinopathy of the main body of tendo Achillis: a randomized controlled trial. Am J Sports Med. 2007; 35:374-383.28.
8. Knobloch K., Kraemer R., Lichtenberg A., Jagodzinski M., Gossling T., Richter M., Zeichen J., Hufner T., Krettek C. Achilles tendon and paratendon microcirculation in midportion and insertional tendinopathy in athletes. American Journal of Sports Medicine. 2006; 34, 92-97
9. Shalabi A, M Kristoffersen-Wilberg, L Svensson, P Aspelin, Movin T. Eccentric training of the gastrocnemius-soleus complex in chronic Achilles tendinopathy results in decreased tendon volume and intratendinous signal as evaluated by magnetic resonance imaging. Am J Sports Med. 2004; 32:1286-1296.
10. Langberg H, Ellingsgaard H, Madsen T, et al. Eccentric rehabilitation exercise increases peritendinous type I collagen synthesis in humans with Achilles tendinosis. Scand J Med Sci Sports. 2007; 17:61.
11. Silbernagel KG. Does one size fit all when it comes to exercise treatment for Achilles tendinopathy. JOSPT. 2014; 44(2)42-44.