

Comparison of Effects of Decline Squat and Forward Lunges in the Treatment of Chronic Patellar Tendinopathy. A Research Protocol

Dimitrios Stasinopoulos^{1*}, Eleni Papadamou² and Areti-Zoi Cheimonidou³

¹Department of Physiotherapy, Faculty of Health and Caring Sciences, University of West Attica, Athens, Greece

²Department of Physiotherapist, MSc student

³Department of Physiotherapist, MSc, PhD Private clinic, Athens, Greece

Abstract

Background: One of the two most common tendinopathies of the lower limb is Patellar Tendinopathy (PT). An exercise programmer consisting of a unilateral squat concentric - eccentric training of the patellar tendon on a 25° decline board has been recommended for the management of PT. In addition, slow progressive eccentric - concentric loading of quadriceps using forward step lunge (FSL) with the anterior knee motion going in front of the toes (FT) is also recommended for the management of PT. The purpose of the present article will be to make a comparison of the effects of a unilateral squat concentric - eccentric training of the patellar tendon on a 25° decline board and an exercise programmer consisting of FSL-FT for the treatment of Chronic PT (CPT). **Methods/Design:** CPT patients will participate in this randomized clinical trial (RCT). Patients will be allocated to two groups randomly. Group A will be treated with unilateral squat concentric - eccentric training of the patellar tendon on a 25° decline board and group B will be treated with FSL-FT. All patients will receive 30 treatments totally (5 treatments/week for 6 weeks). Pain (VISA-P), function (VISA-F) and drop - out will be evaluated at the end of treatment, at 3 months follow-up and at 6 months follow up. The independent t test will be used to determine the differences between groups. A paired t test will be used to determine the difference within groups. The level for statistical significance will be 5% level of probability. SPSS 21.00 will be used for the statistical analysis. **Discussion:** The present RCT will be evaluate the effectiveness of an unilateral squat concentric - eccentric training of the patellar tendon on a 25° decline board and an exercise programmer consisting of FSL-FT for the treatment of CPT.

Keywords: Squat • Lunges • Patellar Tendinopathy

Introduction

Chronic Patellar Tendinopathy (CPT) commonly referred to as Jumper's knee is the most common tendinopathy in the knee area. It is a degenerative condition and not an inflammatory one. Pain and decreased function are the main symptoms of CPT. Diagnosis are simple. The symptoms are reproduced by (1) lower limb activities such as squat or hop; (2) palpation on the site of pain (mainly at the inferior pole of the patella); and (3) clinical tests such as decline test [1].

No ideal treatment has emerged for the management of CPT. Many clinicians advocate a conservative approach [1] and physiotherapy is usually recommended [2]. A wide array of physiotherapy treatments has been recommended for the management of CPT such as electrotherapeutic/physical modalities, exercise programmers, soft tissue manipulation, and manual techniques [3]. These treatments have different theoretical mechanisms of action, but all have the same aim, to reduce pain and improve function. Such a variety of treatment options suggests that the optimal treatment strategy is not known, and more research is needed to discover the most effective treatment in patients with CPT.

Unilateral squat eccentric training of the patellar tendon was the most commonly used conservative approach in the treatment of CPT [4]. Later, it was found that the unilateral squat eccentric training on a 25° decline board applied more load on the tendon [5]. However, squat eccentric training of the patellar tendon alone, on decline board or not, was not effective for many patients with CPT. Malliaras and his colleagues [6] performed a systematic review of studies comparing two or more loading programs in Achilles and patellar tendinopathy. They concluded that clinicians should consider eccentric-concentric loading alongside or instead of eccentric loading.

Others recommend lunges for the management of CPT. There are different techniques for lunges, including variations in step length, walking or jumping

***Address for Correspondence:** Dimitrios Stasinopoulos, 1Department of Physiotherapy, Faculty of Health and Caring Sciences, University of West Attica, Athens, Greece, Tel: 6944743456; E-mail: dstasinopoulos@uniwa.gr

Copyright: © 2021 Dimitrios Stasinopoulos et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Received 26 April 2021; Accepted 11 May 2021; Published 18 May 2021

lunges, or different trunk positions [7]. Keeping the knee behind the toes is a common cue during performing a proper form of lunges [7]. However, the results of a recently published case study suggest that the slow progressive eccentric - concentric loading of quadriceps using forward step lunge (FSL) with the anterior knee motion going in front of the toes (FT) can produce significant improvements in terms of pain and disability in CPT [8].

To our knowledge, there have been no studies to investigate the effectiveness of FSL-FT in patients with CPT. One randomized control trial compared declined squat eccentric loading with FSL-FT in elite basketball players and no in general population [9]. The above-mentioned study showed that the decline squat exercise protocol had higher clinical gains during the rehabilitation of patellar tendinopathy in athletes. Therefore, the aim of the present article will be to make a comparison of the effects of a unilateral squat concentric - eccentric training of the patellar tendon on a 25° decline board and an exercise programmer consisting of FSL-FT for the treatment of CPT.

Methods

A randomized controlled, monocentre trial will be conducted in the Laboratory of Neuromuscular and Cardiovascular Study of Motion (LANECASM) over 12 months to assess the effectiveness of an unilateral squat concentric - eccentric training of the patellar tendon on a 25° decline board and once involving FSL-FT for the treatment of CPT. A parallel group design will be used because crossover designs are limited in situations where patients are cured by the intervention and do not have the opportunity to receive the other treatments after crossover [10]. Three investigators will be involved in the study: (1) a physiotherapist, the primary investigator, (DS) who will evaluate the patients to confirm the LET diagnosis and will allocate patients to groups, (2) a physiotherapist (EP) who will perform all baseline and follow-up assessments, and will gain informed consent and (3) a physiotherapist, (AZC), who will administer the treatments. All assessments will be conducted by EP who will be blind to the patients' therapy group. AC will interview each patient to ascertain baseline demographic and clinical characteristics, including patient name, sex, and age, duration of symptoms, previous treatment, occupation, affected arm and dominant leg.

A sample size of 25 subjects per group is sufficient to demonstrate statistical clinical significance for all outcome measures on CPT. Clinical effects of 20% had been reported as clinically meaningful in placebo-controlled studies measuring pain relief and functional outcomes in response to physiotherapeutic interventions such as low-power laser light. In this study, baseline variance for pain and functional

outcomes will be set at 25%. Power calculations will suggest that a sample size of 25 patients per group is sufficient to detect a 20% change in outcome measures, assuming that variance will be equivalent to 25% with 80% of power and a 5% significant level. The formula that will be used to estimate the appropriate sample size will be:

$$N = 16\sigma^2/d^2$$

where σ^2 is the variability of the data and d^2 is the effect size. For example, in our trial $\sigma = 25$ and $d = 20$. Therefore the above formula is $N = 16 \times 625 / 400 = 25$

Patients over 18 years old who will be experiencing anterior knee pain will be examined and evaluated in the LANEASM in Athens between October 2021 and December 2022. All patients will live in Greece, will be native speakers of Greek and will be either self-referred or referred by their physician or physiotherapist.

The selection criteria for the study will be [1,4]:

- tenderness with palpation over the inferior pole of the patella;
- no history of trauma to the knee;
- minimum duration of symptoms three months;
- unsuccessful conservative treatment before entering the study, but not in the preceding one month;
- no other current knee or lower extremity problems including anterior knee pain, muscle strains and hip or ankle injuries;
- Positive decline squat test [1, 4, 11]. This is a clinical diagnostic test.
- Royal London Hospital test [12]. This is a clinical diagnostic test

All patients will receive a written explanation of the trial prior to entry into the study. All patients will give signed informed consent to participate in the study. The study will be approved by the Ethics Committee of the University of West Attica.

The patients will be randomly allocated to two groups by drawing lots. Patients in Group A will be treated with an unilateral squat concentric - eccentric training of the patellar tendon on a 25° decline board and patients in Group B will be treated with FSL-FT.

All patients will be instructed to use their knee during the course of the study but to avoid activities that will irritate the joint such as jumping, hopping and running. They will also be told to refrain from taking anti-inflammatory drugs throughout the course of study. Patient compliance with this request will be monitored using a treatment diary.

Communication and interaction (verbal and non-verbal) between the therapist and patient will be kept to a minimum, and behaviors sometimes used by therapists to facilitate positive treatment outcomes will be purposefully avoided. For example, patients will be given no indication of the potentially beneficial effects of the treatments or any feedback on their performance in the pre-application and post application measurements [13].

The eccentric - concentric loading will be the same for both groups. As eccentric - concentric training, the participants will be carried out three sets of 15 repetitions of unilateral squat on a 25° decline board or FSL-FT with 1-min rest interval between each set. The squat or FSL-FT will be performed at a slow speed at every treatment session. Participants will count to 6 during the squat or FSL-FT. As the subjects will move from the standing to the squat position of FSL-FT, the quadriceps muscle and patellar tendon by inference will be loaded eccentrically; followed by concentric loading, as the injured leg will be used to get back to the start position. At the beginning the load will be consisted of the body weight and the participants will be standing with all their body weight on the injured leg. The participants will be told to go ahead with the exercise even if they will experience mild pain. However, they will be told to stop the exercise if the pain will become disabling. When the squat or FSL-FT will be pain-free the load will be increased by holding hand weights. Eccentric-concentric loading will be given five times a week for 6 weeks and will be individualized on the basis of the patient's description of pain experienced during the procedure. Static stretching exercises of quadriceps and hamstrings will be performed as described by Stasinopoulos and his colleagues [5] before and after the eccentric - concentric loading. Each stretch will last 30 seconds and there will be a one minute rest between each stretch.

Pain, function and dropout rate were measured in the present study. Each patient was evaluated at baseline (week 0), at the end of treatment (week 6) at 3 month (week 18) and at six months (week 30) after the end of treatment.

The VISA-P questionnaire was used to monitor the pain and function of patients. The instrument is a simple questionnaire, consisted of eight questions that takes

less than five minutes to complete and once patients are familiar with it they will be able to complete most of it themselves. It is a valid and reliable outcome measure for patients with patellar tendinopathy [14]

A dropout rate will be also used as an indicator of treatment outcome. Reasons for patient dropout will be categorized as follows: (1) withdrawal without reason, (2) not returned for follow-up, and (3) request for an alternative treatment.

The change from baseline will be calculated for each follow-up. Differences between groups will be determined using the independent t test. The difference within groups between baseline and end of treatment will be analyzed with a paired t test. A 5% level of probability will be adopted as the level for statistical significance. SPSS 21.00 statistical software will be used for the statistical analysis.

Discussion

The main aim of this RCT is to investigate the effectiveness of two exercise programmes in improving function, strength, and pain in CPT patients at the end of treatment, at 3 months follow-up and at 6 months follow up. It is expected to examine the following null hypothesis: "there is no difference in function and pain for subjects undergoing an unilateral squat concentric - eccentric training of the patellar tendon on a 25° decline board and an exercise programme consisting of FSL-FT for the treatment of CPT".

Alfredson et al. [15] first proposed the eccentric training of the injured tendon. Unilateral squat eccentric training of the patellar tendon was the most commonly used conservative approach in the treatment of CPT [16] when the problem is at the inferior pole of the patella. Later, it was found that the unilateral squat eccentric training on a 25° decline board applied more load on the tendon [5]. However, squat eccentric training of the patellar tendon alone, on decline board or not, was not effective for many patients with CPT. Malliaras and his colleagues [6] concluded that clinicians should consider eccentric-concentric loading alongside or instead of eccentric loading in Achilles and patellar tendinopathy. A Heavy Slow Resistance (HSR) program is recommended in the management of lower limb tendinopathy [17,18]. The HSR program was produced equivalent pain and function improvement (VISA) than the Alfredson eccentric program, but significantly better patient satisfaction at six month follow-up and therefore recommended as initial conservative treatment for CPT [19]. In the Achilles tendon, eccentric and HSR have recently been shown to yield similar clinical outcomes (VISA and patient satisfaction) at 1 year follow up. Based on the above findings, the HSR program can be recommended as an alternative to the Alfredson eccentric program lower limb tendinopathy rehabilitation for young active people.

Recently, isometric exercises have been recommended to reduce and manage tendon pain increasing the strength at the angle of contraction without producing inflammatory signs [20,21]. Five repetitions of 45-second isometric mid-range quadriceps exercise at 70% of maximal voluntary contraction have been shown to reduce patellar tendon pain for 45 minutes post exercise and this was also associated with a reduction in motor cortex inhibition of the quadriceps that was associated with patellar tendinopathy [21]. The dosage of isometric contractions is based on clinical experience [20-22] and their effect on pain in patients with CPT requires further study. The 'Spanish squat' is used as isometric contraction and is useful when there is limited or no access to gym equipment [20]. However, conflicting results have been reported in terms of immediate and short-term pain relief [23]. Definitive conclusions about the effectiveness of isometric exercise in tendinopathy are yet to be made [23].

A component lacking from evidence-based programs is adequate potential to alter load distribution on the lower limb kinetic chain and increase the risk of lower limb tendinopathy [1,24]. It is our belief that the improvement of lumbo-pelvic control can be achieved by performing simple exercises such as single leg bridging in supine and four - point prone bridging exercises. Future research is needed to confirm this suggestion.

In addition, hip extensors weakness has been associated with patellar tendinopathy [25]. Exercises to strengthen these muscle groups should be considered in exercise protocols and patellar tendinopathy. Functional activities such as jumping, cutting and sprinting should also be included in lower limb tendinopathy rehabilitation programs among athletes, but have so far not been included in popular programs in the literature [25].

There are different techniques for lunges, including variations in step length, walking or jumping lunges, or different trunk positions [7]. Keeping the knee behind the toes is a common cue during performing a proper form of lunges [7]. Research is needed to find out 1) which technique of lunges is the most effective and 2) if the lunge is more effective treatment approach than squat for CPT patients and 3) the load applied to the patellar tendon during the lunges.

The load of exercises is increased according to the patients' symptoms otherwise the results are poor [26]. Furthermore, eccentric exercises are performed at a low speed in every treatment session because this allows tissue healing [27]. Ice will not be recommended at the end of the treatment because research has shown that ice as a supplement to an eccentric exercise programme offers no benefit to patients with tendinopathy [28]. Finally, the avoidance of painful activities is crucial for tendon healing, because training during the treatment period increases patients' symptoms and delays tendon healing [29].

Although a home exercise programme can be performed any time during the day without requiring supervision from a therapist, our clinical experience has shown that patients fail to comply with the regimen of home exercise programmes [28]. Although many ways can be recommended to improve the compliance of patients with the home exercise programme such as phone calls, exercise monitors and better self-management education, it is believed that this problem can be solved by the supervised exercise programmes performed in a clinical setting under the supervision of a therapist. It is believed because our experience has shown that many patients stopped the home exercise programme without giving an explanation, whereas patients completed the supervised programme. One possible reason why they continue the supervised exercise programme could be the cost. In the supervised exercise programme, the patients visit the therapist more times than the home exercise programme, and this is more expensive. A future study will combine the both types of exercise programmes in order to maximize the compliance of the patients.

Future well-designed clinical trials are needed to confirm the results of this trial establishing the effectiveness of such an exercise program in the management of CPT. In addition, structural changes in the tendons related to the treatment interventions and the long-term effects (more than 6 months after the end of treatment) of these treatments are needed to investigate. Further research is needed to establish the possible mechanism of action of this treatment approach, and the cost effectiveness of such treatment, because reduced cost is an important issue for the recommendation of any given treatment.

Conclusion

This is the first study to assess the effectiveness of FSL-FT in the management of CPT. It is expected, the study conclusion to contribute to the fund of scientific knowledge providing evidence that using FSL-FT is a safe and effective tool in the management of CPT symptoms, specifically pain and function.

References

- Kountouris, Alex, and Jill Cook. "Rehabilitation of Achilles and patellar tendinopathies." *Best Practice Res Clin Rheumatol* 21(2007): 295-316.
- Peers, Koen HE, and Roeland JJ Lysens. "Patellar tendinopathy in athletes." *Sports Med* 35(2005): 71-87.
- Stasinopoulos, Dimitrios. "Patellar tendinopathy may not be the proper term for patients with clinical diagnosis of patellar tendon disorder." *Trauma Monthly* 19 (2014).
- Cook, Jill L., Karim M. Khan, and Craig R. Purdam. "Conservative treatment of patellar tendinopathy." *Phys Ther Sport* 2(2001): 54-65.
- Stasinopoulos, Dimitrios, and Ioannis Stasinopoulos. "Comparison of effects of Cyriax physiotherapy, a supervised exercise programme and polarized polychromatic non-coherent light (Bioptron light) for the treatment of lateral epicondylitis." *Clin Rehabil* 20(2006): 12-23.
- Malliaras, Peter, Christian J. Barton, Neil D. Reeves, and Henning Langberg. "Achilles and patellar tendinopathy loading programmes." *Sports Med* 43(2013): 267-286.
- Zellmer, Matthew, Thomas W. Kernozek, Naghmeh Gheidi, Jordan Hove, and Michael Torry. "Patellar tendon stress between two variations of the forward step lunge." *J Sport Health Sci* 8(2019): 235-241.
- Stasinopoulos D The Effectiveness of lunges and static stretching exercises on Pain and Disability in Chronic Patellar Tendinopathy: A Case Report Orthopedics and Sports Med Open Access J 5(2)- 2021.
- Kumar, P. G., N. Balamurugan, R. Rajavel, and Baby Sargunum. "Comparison between the effectiveness of decline squat exercise and forward lunges in athletes with patellar tendinopathy." *Drug Invention Today* 14(2020).
- Johannsen, F.,A. Gam, B. Hauschild, B. Mathiesen, and L. Jensen. "Rebox: an adjunct in physical medicine?." *Archives Of Phys Med Rehabil* 74(1993): 438-440.
- Stasinopoulos, Dimitrios, and Ioannis Stasinopoulos. "Comparison of effects of exercise programme, pulsed ultrasound and transverse friction in the treatment of chronic patellar tendinopathy." *Clin Rehabil* 18(2004): 347-352.
- Maffulli, Nicola, Francesco Oliva, Mattia Loppini, Rocco Aicale, Filippo Spiezia, and John B. King. "The Royal London Hospital test for the clinical diagnosis of patellar tendinopathy." *Muscles, Ligaments Tendons J* 7(2017): 315.
- Vicenzino, Bill, David Collins, and Anthony Wright. "The initial effects of a cervical spine manipulative physiotherapy treatment on the pain and dysfunction of lateral epicondylalgia." *Pain* 68(1996): 69-74.
- Visentini, Paul J., Karim M. Khan, Jill L. Cook, Zoltan S. Kiss, Peter R. Harcourt, John D. Wark, and Victorian Institute of Sport Tendon Study Group. "The VISA score: an index of severity of symptoms in patients with jumper's knee (patellar tendinosis)." *J Sci Med Sport* 1(1998): 22-28.
- Alfredson, Håkan, Tom Pietilä, Per Jonsson, and Ronny Lorentzon. "Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinosis." *The Am J Sports Med* 26(1998): 360-366.
- Cook, Jill L., Karim M. Khan, and Craig R. Purdam. "Conservative treatment of patellar tendinopathy." *Phys Ther Sport* 2(2001): 54-65.
- Beyer, R., and M. Kongsgaard. "øhlenschlaeger T, Kjaer M, Magnusson SP. Heavy slow resistance versus eccentric training as treatment of Achilles tendinopathy: A randomized controlled trial." *Am J Sports Med* 43(2015): 1704-11..
- Kongsgaard, M., V. Kovanen, P. Aagaard, S. Doessing, P. Hansen, A. H. Laursen, N. C. Kaldau, M. Kjaer, and S. P. Magnusson. "Corticosteroid injections, eccentric decline squat training and heavy slow resistance training in patellar tendinopathy." *Scandinavian J Med Sci Sports* 19(2009): 790-802.
- Breda, Stephan J., Edwin HG Oei, Johannes Zwerver, Edwin Visser, Erwin Waarsing, Gabriel P. Krestin, and Robert-Jan de Vos. "Effectiveness of progressive tendon-loading exercise therapy in patients with patellar tendinopathy: a randomised clinical trial." *British J Sports Med* 55(2021): 501-509.
- Malliaras, Peter, Jill Cook, Craig Purdam, and Ebonie Rio. "Patellar tendinopathy: clinical diagnosis, load management, and advice for challenging case presentations." *J Ortho Sports Phys Ther* 45(2015): 887-898.
- Rio, Ebonie, Dawson Kidgell, Craig Purdam, Jamie Gaida, G. Lorimer Moseley, Alan J. Pearce, and Jill Cook. "Isometric exercise induces analgesia and reduces inhibition in patellar tendinopathy." *British J Sports Med* 49(2015): 1277-1283.
- Stasinopoulos, D. "The effectiveness of isometric contractions combined with eccentric contractions and stretching exercises on pain and disability in lateral elbow tendinopathy." *a case report. J nov physiother* 5, 238(2015): 2.
- Clifford, Christopher, Dimitris Challoumas, Lorna Paul, Grant Syme, and Neal L. Millar. "Effectiveness of isometric exercise in the management of tendinopathy: a systematic review and meta-analysis of randomised trials." *BMJ Open Sport & Exercise Med* 6(2020): e000760.
- Dimitrios, S. "Achilles tendinopathy and lumbopelvic Stability." *Rheumatology* 4 (2013): 2161-1149.
- Silva, Rodrigo Scatone, Ana Luisa G. Ferreira, Theresa H. Nakagawa, José EM Santos, and Fábio V. Serrão. "Rehabilitation of patellar tendinopathy using hip extensor strengthening and landing-strategy modification: case report with 6-month follow-up." *J Ortho Sports Phys Ther* 45(2015): 899-909.
- Jensen, Kris, and Richard P. Di Fabio. "Evaluation of eccentric exercise in treatment of patellar tendinitis." *Physi Ther* 69(1989): 211-216.
- Kraushaar, Barry S., and Robert P. Nirschl. "Tendinosis of the elbow (tennis elbow): clinical features and findings of histological, immunohistochemical, and electron microscopy studies." *J Bone and Joint Surg* 81(1999): 259.
- Manias, Pantelis, and Dimitrios Stasinopoulos. "A controlled clinical pilot trial to study the effectiveness of ice as a supplement to the exercise programme for the management of lateral elbow tendinopathy." *British J Sports Med* 40(2006): 81-85.
- Visnes, Håvard, Aasne Hoksrud, Jill Cook, and Roald Bahr. "No effect of eccentric training on jumper's knee in volleyball players during the competitive season: a randomized clinical trial." *Scandinavian J Med Sci Sports* 16(2006): 215-215.

How to cite this article: Dimitrios Stasinopoulos, Eleni Papadamou, Areti-Zoi Cheimonidou. "Comparison of Effects of Decline Squat and Forward Lunges in the Treatment of Chronic Patellar Tendinopathy. A Research Protocol". *Physiother Rehabil* 6 (2021):222.