

BMJ Open Effect of a common exercise programme with an individualised progression criterion based on the measurement of neuromuscular capacity versus current best practice for lower limb tendinopathies (MaLaGa trial): a protocol for a randomised clinical trial

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ABSTRACT

Introduction High-load resistance training has shown positive effects in pain and function in lower limb tendinopathies. However, some authors suggest that current exercise programmes produce an increase in tolerance to load and exercise in general but without fixing some existing issues in tendinopathy. This may indicate the need to include training aspects not currently taken into account in the current programmes. The main objective of this study will be to compare the effect of a common exercise protocol for the three predominant lower limb tendinopathies (Achilles, patellar and gluteal), based on an individualised control of the dose and training of specific aspects of the neuromuscular system versus the current best practice for each location.

Methods and analysis This study will be conducted among people with mid-portion Achilles, patellar or gluteal tendinopathy. The participants allocated to the experimental group will perform a 14-week innovative common therapeutic exercise programme. Participants allocated to the control group will carry out a 14-week exercise programme based on the best current practice for each of the studied locations. The Victorian Institute of Sports Assessment questionnaire will be considered the primary outcome. Pain, central sensitisation, fear avoidance behaviour, quality of life, treatment satisfaction, lower-limb strength and function, and high-density electromyography profile will be evaluated as secondary outcomes. Outcomes will be assessed at baseline, 7 weeks, after the intervention (week 14), 26 weeks and 52 weeks.

Ethics and dissemination The study has been approved by the Portal de Ética de la Investigación Biomédica de Andalucía Ethics Committee (1221-N-19). All participants will be informed about the purpose and content of the study and written informed consent will be completed. The results of this study will be published in a peer-reviewed journal and will be disseminated electronically and in print.

Trial registration number NCT03853122; Pre-results.

Strengths and limitations of this study

- This study protocol has been designed according to the Standard Protocol Items: Recommendations for Interventional Trials declaration.
- The single-blind, randomised controlled design of this protocol will allow this study to reach a high level of evidence.
- The design of a common exercise programme for three different sites of tendinopathy, if proven effective, can be an important advance for standardisation in clinical practice.
- The proposed new approach to exercise programmes based on the individualisation of the load and progression criteria, as well as the training of different neuromuscular characteristics, could allow a simplification of the variety of exercises of the different tendinopathies with equal or superior results.
- A possible limitation of this study may be the difficulty in comparing results from three tendinopathy locations with some differential characteristics.

BACKGROUND

Although the pathogenesis of tendinopathy has not yet been fully understood, different conceptual models have been proposed to explain this from a structural point of view, and the theory of an initial response of tendon cells to excessive loading prevails.^{1 2} Likewise, there is also evidence about the presence and negative influence of psychosocial factors such as catastrophisation, distress and kinesiophobia in the outcomes and prognosis of tendinopathy.³ Regarding treatment options, the literature published in recent decades points to progressive therapeutic exercise as the first-line treatment for lower

limb tendinopathy.²⁻⁴ Different mechanisms have been proposed to explain the effects of exercise programmes in tendinopathy, including local effects on tendon and muscle structure,^{5,6} and central neuroplastic changes.⁷

Isolated isometric contractions have shown significant positive results on acute pain relief in patellar tendinopathy.^{8,9} In addition, using isometric contractions prior to a resistance training seems to improve strength gains.⁸ However, a recent study found no differences between isometric and dynamic resistance exercise on acute pain. This suggests that the specific contraction modality may not be the most relevant element, but the progressive exercise itself.¹⁰ This approach is especially useful during the early stages of an exercise programme or during sports season to relieve symptoms in the short-time, although it is dependent on neurophysiological modulation and not seems to produce structural changes to reverse the tendinopathy itself.^{10,11}

For mid-term and long-term improvement in tendinopathies, high-load resistance training has shown positive effects.^{12,13} Thus, there is a marked preference for the use of isolated eccentric loading due to the enormous popularity the Alfredson protocol achieved two decades ago.¹⁴ This popularity triggered an extensive literature and clinical practice applying this approach, predominantly in the Achilles and patellar tendinopathies.² Nevertheless, some systematic reviews published during the last years have observed that despite its widespread use there is a lack of evidence in favour of the isolated eccentric training and the parameters applied in this programme, and similar results have been found with other exercise approaches.^{5,12,15,16} At the present time, the heavy slow resistance and the eccentric exercise training programmes have demonstrated the greatest long-term pain relief and improvement in function, not finding significant differences between both programmes.^{5,13,16} Despite the absence of significant differences in function and pain, a study observed reductions of tendon abnormality and an increased collagen turnover in a group performing heavy slow resistance training and not in a group where isolated eccentric training was executed.⁵ Nevertheless, the enormous popularity of the eccentric protocol and its significant simplicity have sustained an extended application of this approach.

In gluteal tendinopathy, the current evidence for training parameters is scarce. A previous study showed better global improvement of an exercise programme plus education versus a non-intervention and a corticosteroid injections group.¹⁷ In the function, assessed with the Victorian Institute of Sports Assessment questionnaire for gluteal tendinopathy (VISA-G) at 8 weeks, significant differences were found in favour of the exercise plus education group. However, the differences between the exercise and the corticosteroids groups were not statistically significant (but clinically) at the 52-week follow-up. The programme applied in this study was a novel protocol based on conditioning stages in which different predefined exercises, frequency, volume and

intensity were applied in each week. Nevertheless, in the attempt to ensure a wide variability of working areas and exercises, it resulted in a complex training protocol with a high number of exercises.

Considering all the above, it seems that although most of the programmes produce positive effects in pain and function, an optimal loading programme has not yet been described.² In this sense, some authors suggest that the significant differences usually found within the groups, without significant differences between groups, could indicate an increase in tolerance to load and exercise in general, but without solving some issues found in tendinopathy.¹⁸

This may indicate the need to include aspects not currently taken into account in the programmes. Current programmes are focused on performing very specific exercises and not individualising the neuromuscular needs and abilities of the patient. Therefore, although a certain consensus has been established about the need for working different characteristics of the neuromuscular system (pain relief, strength gaining, increase in speed and energy storage exercises and sports specific exercises),² most of the current methodologies work a single type of strength manifestation during the full programme, only increasing progressively the workload. Moreover, according to a previous review there is a predominant use of pain-based criteria, but the utilisation of these criteria is not supported by strong evidence.¹⁹

An objective individualisation of the load and progression criteria, as well as the implementation of stages, applying different speeds and loads for the training of different neuromuscular characteristics, could allow a simplification of the number of exercises performed in the three tendinopathies with equal or superior results. Thus, the development of a common programme for the three most predominant tendinopathies of the lower limb (Achilles, patellar and gluteal) could simplify its implementation by clinicians. This programme should be based on developing a personal assessment in the manner of precision medicine. Additionally, it should try to be a progressive and generalisable standard protocol that takes into account the capabilities of the individual.

The main hypothesis is that it is possible to obtain equal or superior benefits in function, pain, and quality of life with a common programme for the three tendinopathies, simplifying the execution to only four movements and putting the focus of individualisation on the load progression criteria and the training of different neuromuscular characteristics.

The primary objective of this study is to compare the effect of a common exercise protocol for the three predominant lower limb tendinopathies, based on an individualised control of the dose and training of specific aspects of the neuromuscular system versus the current best practice in the treatment of each of the three studied lower limb tendinopathies.

As secondary objectives, it is proposed: (1) Develop an exercise systematisation based on the differentiation of

stages with different aims based on the capabilities of the neuromuscular system and (2) Develop a methodology for the quantification of the intensity of the loads based on specific tests for each of the aspects of the neuromuscular system worked.

METHODS AND ANALYSIS

Trial design

This protocol (v1) describes a single-blind, parallel, randomised controlled trial (RCT) that will be conducted among people with lower limb tendinopathy, what is expected to start during the year 2021. The study has been approved by the Portal de Ética de la Investigación Biomédica de Andalucía Ethics Committee (1221-N-19). This protocol has been reported according to the Standard Protocol Items: Recommendations for Interventional Trials Declaration. The study will be published following the Consolidated Standards of Reporting Trials checklist to ensure transparent and standardised reporting of the trial.²⁰

The trial adheres to the principles of the Declaration of Helsinki. All participants will be informed about the purpose and content of the study. Written informed consent will be completed from all individual participants included in the study.

Patient and public involvement

Patients will be involved in the conduct of this study. During the design stage, different inputs were received from patients with tendinopathy, which helped in the elaboration of the protocol. Once the trial has been published, participants will be informed of the results through a mail and will be sent details of the results in a study newsletter suitable for a non-specialist audience.

Participants

Recruitment details

People with mid-portion Achilles, patellar or gluteal tendinopathy will be recruited from a Spanish Health Centre.

Potential participants will be identified by one of the two medical specialists who will act as recruiters. The recruiters will identify people with at least one of the three studied lower limb tendinopathies and will establish compliance with the selection criteria described below. All subjects will be informed about the purpose and characteristics of the study, and they will be asked to be included in the study.

Eligibility criteria

Due to the specific characteristics of each of the studied tendinopathies, general and specific eligibility criteria to each region will be established.

General inclusion criteria

1. People between 18 and 65 years with a clinical diagnosis of mid-portion Achilles, patellar or gluteal tendinopathy.
2. Pain duration for at least 1 month.

General exclusion criteria

1. Corticosteroid injection in the studied tendon in the last 12 months.
2. Other injuries in the affected lower limb in the last 12 months.
3. Previous surgery for musculoskeletal causes of the affected lower limb in the last 12 months.
4. Tendinous rupture history in the affected lower limb.
5. Systemic diseases such as rheumatic arthritis or diabetes mellitus.

Specific eligibility criteria for gluteal tendinopathy

Inclusion criteria: Lateral hip pain, an intensity of pain of at least 4/10 on a 11-point numeric rating scale (0=no pain, 10=worst pain imaginable) and clinical diagnosis of gluteal tendinopathy by a doctor (with functional assessment of physiotherapy).¹⁷

Exclusion criteria: Low-back, sciatic or inguinal pain of an intensity greater than 2/10 on a numerical scale.¹⁷

Specific eligibility criteria for patellar tendinopathy

Inclusion criteria: Pain localised to the inferior pole of the patella at palpation and during jumping and landing activities, pain during testing on the single-leg decline squat,⁹ and an intensity of pain of at least 3/10 on an 11-point numeric rating scale (0=no pain, 10=worst pain imaginable). Pain is localised by the patient using only one or two fingers.²

Exclusion criteria: Presence of a diffuse knee pain indicative of possible patellofemoral pain.¹⁰

Specific eligibility criteria for Achilles tendinopathy

Inclusion criteria: pain and swelling at 2–7 cm from the calcaneal insertion.²¹

Exclusion criteria: diagnosis of insertional Achilles tendinopathy.²¹

Imaging tests such as magnetic resonance or ultrasound imaging have shown only poor or moderate correlation with pain in tendinopathy.^{22–23} Besides, recently in the International Scientific Tendinopathy Symposium Consensus: Clinical terminology 2019, it was agreed that imaging is not always necessary for a diagnosis of tendinopathy as it is a clinical diagnosis.²⁴ For this reason, only clinical diagnostic criteria will be considered for eligibility.

Concealed allocation

The allocation will be concealed by sealed opaque envelopes. For this, an assistant not involved in the study will prepare sealed and numbered consecutively opaque envelopes. Each envelope will be assigned a group randomly by a computer-generated random number list. They will be kept in a locked file cabinet only accessible to the assistant. Once the fulfilment of the selection criteria and the participation in the study are confirmed, each subject will receive an envelope sequentially and will be assigned to the corresponding group.

Interventions

At the beginning of the programme, participants in both groups will receive individual education on basic pathophysiology of tendinopathy and the risk factors for each of the locations. Likewise, they will receive education on the identification of normal symptoms and signs and those that indicate an excess in the dose, as well as on an adequate load selection and progression.

Experimental group

The participants allocated to the experimental group will perform an innovative therapeutic exercise programme consisting of the training of different neuromuscular characteristics and a quantification and load progression based on the use of functional tests.

The programme of the experimental group will consist of 14 weeks in which 70 individualised physiotherapy sessions will be conducted, including supervised and semisupervised sessions. A minimum of 14 sessions will be conducted in a supervised face-to-face way, including seven sessions aimed at conducting control sessions for teaching and monitoring the exercises and seven sessions aimed at carrying out the tests for the quantification of the load. Thirty-seven sessions will be conducted in a semisupervised manner, performing the exercises autonomously, but with possible assistance from instructors. Additionally, participant will conduct 28 sessions of unsupervised individualised aerobic training. These sessions will be conducted with an intensity between 60% and 75% of VO_2^{max} , obtained using a submaximal stress test performed at baseline and at the beginning of the eighth week.

The neuromuscular resistance exercise programme will consist of five stages divided into 2, 4, 4, 2 and 2 weeks, respectively. The frequency of the neuromuscular strength training will be of 3 weekly sessions. Additionally, 2 weekly sessions of aerobic work will be done. The approximate duration of each session will be 30 min. The exercises (four exercises) will be common for the three different locations of the tendinopathies. Two of the exercises will be performed alternately in each session. During the first four stages, these exercises are based on four different positions of the feet in the leg press (feet shoulder-width apart; left foot forward; right foot forward; feet apart with 45° external rotation). These four positions are chosen because they offer greater variability in a triple extension movement (hip, knee and ankle extension) such as leg press exercise. This exercise has previously been used in patellar tendinopathy protocols,⁵ but the triple extension movement could be beneficial for the function of the three tendon studied in a large number of activities of daily living. In each of the stages, load and speed parameters will be modified to influence different aspects of the neuromuscular system. During stage 5, the exercises will consist of four different jumping modalities (countermovement jump, CMJ; drop jump, DJ; DJ with dual task and repeated vertical jumps). This work will be

complemented throughout the programme by 2 weekly sessions of aerobic exercise.

Aerobic exercise: Numerous studies have proven during the last decades the effect of exercise as an excellent ‘polypill’ that would have a positive impact on many body systems.⁵ Thus, in addition to the effects that aerobic exercise may have on cardiorespiratory capacity, endurance or performance, aerobic exercise can affect the hypothalamic–pituitary–adrenal axis,⁶ release exercise-induced myokines⁷ or increase sensitivity to catecholamines,⁸ among others potential effects. Aerobic exercise can help not only by allowing a progressive return to sports activity but also by providing a potential analgesic and recovery-accelerating effect. Although the use of a cycle ergometer makes it possible to standardise this part of the training for most people, due to the objective of this type of training it could be adapted to other forms of aerobic training such as running outdoors or on a treadmill. This would also include a possible aerobic training of the upper limbs (eg, using an upper body ergometer or generic upper limb exercises with an aerobic nature) in the early stages in those cases in which the symptoms do not allow do not allow adequate lower limb work.

Stage 1: based on isometric contractions to control symptoms and prepare the neuromuscular system for later phases. The use of isometric contractions has shown some benefits in tendinopathy such as a reduction in cortical inhibition^{7,8} or immediate^{8,25} and short-term^{25,26} analgesia. The absence of differences between different protocols suggests that the effects may be more related to obtaining adequate intensity and time under tension than to specific exercise parameters.²⁵

Stage 2: this stage includes isotonic and heavy slow resistance exercises and has been proposed by many authors with the aim of improving muscle strength and tendon stiffness.^{2,27,28} The main novelty in this study is the incorporation of a methodology based on time under tension and not on the number of repetitions. Thus, the importance of ensuring sufficient time under tension lies in the fact that greater time under tension with the same volume load produces greater overall muscular fatigue²⁹ and a greater impact on the metabolic responses,³⁰ which can translate into additional neuromuscular adaptations.

Stage 3: based on strength training through exercises performed with a velocity loss of 20%. This type of training has been shown to be superior to others (velocity loss of 0%, 10% and 40%) with the greatest increases in muscle hypertrophy, avoiding the negative neuromuscular adaptations observed in work with greater velocity losses.³¹

Stage 4: based on high-load strength training. High-load resistance training has been found to be a good way to obtain maximal strength benefits.^{32,33} For some decades, these increases in strength not explained solely by increases in hypertrophy have been attributed to neural adaptations.^{32–35}

Stage 5: based on plyometric training, jumps and improvement of the energy storage capacity of the

tendon. This type of training has been recommended for tendinopathy by several authors.^{27 28 36 37}

In the different stages, the dose tests are designed to calculate the load needed for the appearance of fasciculations (stage 1), the inability to continue moving the load (stages 2 and 4) and a loss of speed of 20% (stage 3) on a given time, or to calculate the height maximum that can be maintained in repeated vertical jumps that can be maintained for a specified time (stage 5). In general, the working time of each series has been chosen to be less than the time calculated in the test. This fact, together with a high number of series, allows a different work in the first series, focused on accumulating volume, and in the last series, where due to neuromuscular fatigue a limit similar to that obtained in the test is reached.

Specific intervention details, as well as detailed information of each of the stages, are available in online supplemental file.

Control group

Participants allocated to the control group will carry out a 14-week therapeutic physical exercise programme.

The programme will be based on the isolated eccentric training protocol described by Alfredson¹⁴ for Achilles tendinopathy. The Alfredson's protocol modified version of Purdam *et al*³⁸ and the LEAP protocol of Mellor *et al*¹⁷ will be applied for patellar and gluteal tendinopathy, respectively. The three protocols will be adapted to be carried out in 14 weeks in order to match the training of the control and intervention groups. Detailed information on the protocol and exercises used is available in online supplemental file. The control group will carry out the same number of supervised sessions as the intervention group (14 sessions), performing the remaining sessions autonomously but with the help of an instructor when necessary. Participants of both groups will keep track through an activity diary. The flow chart of the study is shown in figure 1.

Participants will be allowed to perform light and moderate physical activity as long as it does not produce an increase in symptoms both during and especially at 24 hours (Visual Analogue Scale (VAS) >50 mm). Likewise, they will be recommended to abandon those workouts

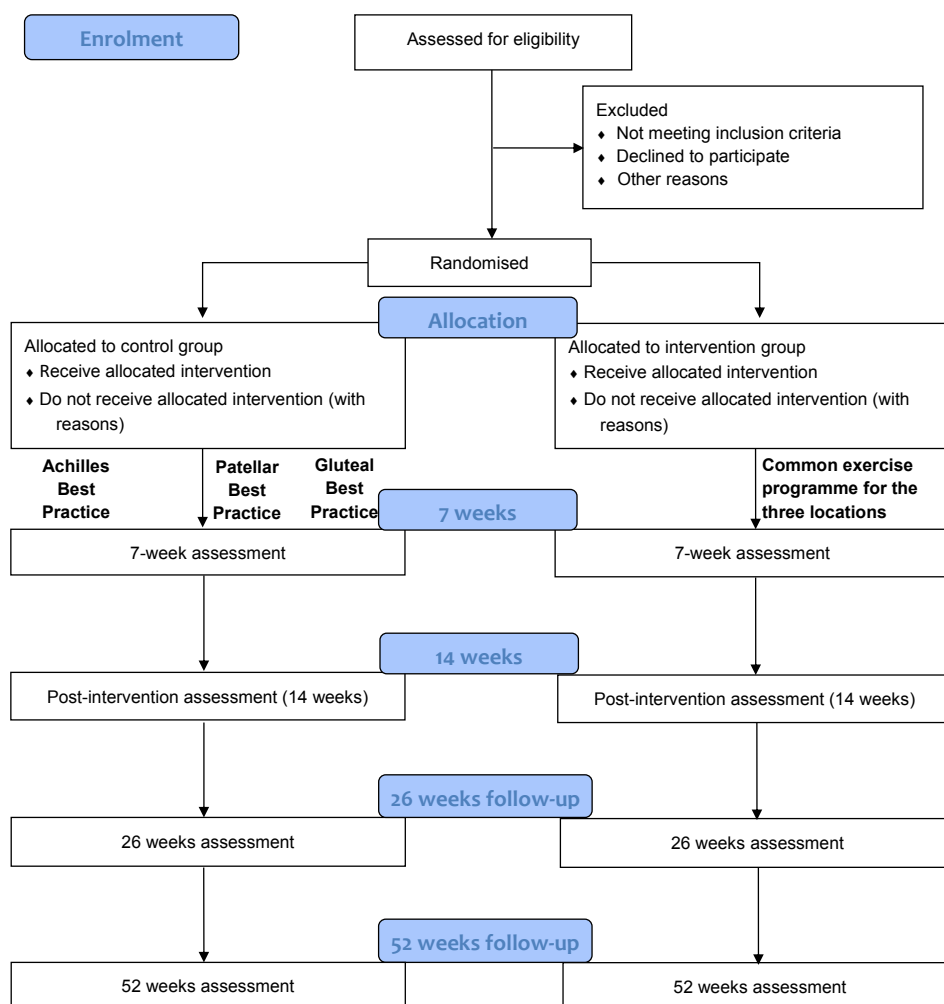


Figure 1 Flow chart of the study.

that do not allow adequate recovery between sessions when applied together with the training programme proposed in this study.

Outcome measures

Both groups will be evaluated at the beginning, in the middle (7 weeks), and at the end of the programme, as well as in medium-term (26 weeks) and long-term (52 weeks) follow-up. The assessments and the control and resolution of possible events that may occur will be under the supervision of a researcher. The same assessor, blinded to the group allocation of the participants, will measure each outcome at each of the measurements.

Primary outcome measures

The VISA questionnaire (VISA-A, VISA-P and VISA-G for Achilles, patellar and gluteal tendinopathy, respectively)^{39–41} will be considered the primary outcome and will be used to assess the effectiveness of the programme applied in each group. The VISA-A and VISA-P have been adapted and validated for the Spanish population showing satisfactory psychometric properties similar to the original English-language version.^{42 43}

Secondary outcome measures

Additionally, the following secondary outcomes will be evaluated:

Visual Analogue Scale

A VAS from 0 to 100 mm will be used to record the amount of pain in the tendon at rest (VASr) and during running activity (VASa), 0 being no pain and 100 being the worst imaginable pain.^{44 45} Additionally, subjects will be asked about how much time elapses when they are running until the onset of pain, in order to obtain complementary information.

Pressure pain threshold

A hand-held algometer (FPK 20, Wagner Instruments, Greenwich, USA) with a 1 cm² probe will be used to assess the pressure pain threshold at rest in the tendon.⁴⁶ Subjects will be positioned lying prone with the ankle in neutral position (90°) for the Achilles tendon,⁴⁷ sitting with the knee flexed to 90° for the patellar tendon,¹⁰ and lying in the lateral decubitus position with hip joints slightly flexed for the gluteal tendon.⁴⁸ The tester will be placed perpendicular to the skin over the test area, increasing the pressure 30 kPa/s.¹⁰ Participants will be instructed to indicate when the sensation change from comfortable pressure to slightly unpleasant pain. Test will be repeated three times with 1 min of rest between repetitions. The mean value will be used for the analysis.¹⁰

Örebro Musculoskeletal Pain Questionnaire

The Örebro Musculoskeletal Pain Questionnaire is a self-administered pain screening questionnaire used to identify patients with acute or subacute musculoskeletal pain who are at risk of delayed recovery. This tool

aims to detect and quantify the existence of biopsychosocial aspects that may negatively affect the patient's prognosis. With a maximum punctuation of 210, a score lower than 105 points is related to low disability, a score between 105 and 130 points suggests a moderate disability, and a score higher than 130 points is related to high disability.⁴⁹ The adaptation and validation version of this questionnaire for the Spanish population has shown a rate above 0.85 on reliability in most of the variables.⁵⁰

Central Sensitisation Inventory

The Central Sensitisation Inventory inventory will be used to identify and quantify the degree of key symptoms associated with the central sensitisation syndrome present in the included subjects.⁵¹ The score ranges from 0 (best score) to 100 (worst score). This index has been adapted and validated to Spanish with an SE of the measurement of 2.52%.⁵²

Fear Avoidance Components Scale

The Fear Avoidance Components Scale (FACS) scale is used to comprehensively assess the presence of fear avoidance beliefs and attitudes in the participants. The FACS instructions ask participants to reflect on past painful experiences and to indicate the degree to which these experiences influence on their activity. There are 20 thoughts or feelings related to fear avoidance which are scored using 6-point scales with the end points 0, completely disagree and 5, completely agree. The FACS yields a total score between 0 (best score) and 100 (worst score), and have showed a high test/retest reliability (r=0.90–0.94).⁵³

EuroQol-5Dimension-5Level

The EuroQol-5Dimension-5Level (EQ-5D-5L) has been developed and validated in numerous languages and populations. This questionnaire is used to measure the health-related quality of life. This self-reported tool records the subject's perceptions of their own current overall health status assessing five dimensions (mobility, self-care, usual activities, pain/discomfort and anxiety/depression). It is applied with a short questionnaire and a VAS. Each dimension is rated in five levels from 'I have no problem with...' to 'I am unable to...'.⁵⁴ It has been validated in the Spanish population as an adequate instrument to measure perceived health.⁵⁵

International Physical Activity Questionnaire Short Form

The International Physical Activity Questionnaire Short Form assess the type and amount of physical activity of the patients through seven questions about the physical activity performed the previous 7 days. Physical activity can be interpreted as a numerical value (reported as Median Metabolic Equivalent of Task-minutes per week) or as low, moderate or high activity levels. This form has shown acceptable measurement properties.⁵⁶

Treatment satisfaction

Treatment satisfaction will be assessed using a VAS, from 0 to 100 mm, with 0 being 'not at all satisfied' and 10 being 'extremely satisfied'. This tool has been shown to be less vulnerable to confounding factors and ceiling effect than asymmetric Likert scale.⁵⁷

Lower-Limb Functional Index

The Lower-Limb Functional Index (LLFI) is an index designed for assessing the functional capacity of the lower limbs with a combination of constructs that includes body functions, body structures, activities and participation, and environmental factors. The LLFI contains 25 ideas as items and participants have to select which ones they identify with. The LLFI yields a total score (between 100, best score and 0, worst score).⁵⁸ The Spanish version of this index has been validated showing high reliability (ICC=0.96).⁵⁹

Lower-limb strength

The lower-limb strength will be assessed with two different methods. First, the isometric strength will be assessed in a leg press machine using a s-beam load cell as performed in a previous study.⁶⁰ Additionally, isometric strength will be measured with a hand-held dynamometer following the methodology of a previous study (ankle plantarflexion for Achilles tendinopathy, knee extension for patellar tendinopathy, and hip abduction for gluteal tendinopathy).⁶¹ In both measurements, two repetitions will be conducted and the mean value will be used for the analysis.

High-density electromyography

The High-density electromyography (HDEMG) profile will be calculated using non-invasive surface HDEMG in the quadriceps muscle. Participants will execute maximal isometric voluntary contractions in a leg press machine. Surface HDEMG will be recorded during 20 s. The data obtained will be analysed to extract the mean discharge rate of the motor units (in fires per second) and the recruitment and derecruitment threshold (in Nw). The HDEMG profile will only be assessed in a randomly selected subgroup of each arm.^{62–65}

Other measures

Not per-protocol treatments.

Participants will be encouraged to follow the assigned interventions, trying to avoid any treatment external to the study. They will be informed of the importance of compliance with the programmes, and they will be asked to record any deviation from the protocol in a diary.

Data management

The answers obtained in the VISA questionnaire will be converted into their corresponding score for each subject. The difference in means obtained in each group between the baseline evaluation and at the end of the programme (14 weeks) will be used to determine the success of each treatment.

Sample size

The treatment effect will be evaluated by comparing success rates on the VISA measurements at follow-up between groups. With an a priori calculation based on the effect size of the LEAP study for gluteal tendinopathy ($d=0.59$),¹⁷ and using an α value of 0.05 and a power of 0.8, the sample size is estimated at 44 participants per arm. Assuming losses of 15% of the sample in the follow-up measurement, the necessary sample size will be of 52 participants per group for a total sample of 104 participants.

Blinding

Due to the nature of the study, neither therapists nor subjects can be blinded. Nevertheless, the researchers responsible for the assessment and analysis of the results will be blinded to the allocation of the participants.

Statistical analysis

Statistical analyses will be conducted based on an intention-to-treat approach. A one-way analysis of variance will be carried out both at the beginning and at each of the measurement times to verify the existence of significant differences between groups. If a non-parametric distribution is found, a Kruskal-Wallis test will be carried out at each measurement time. No subgroup or additional analyses are planned a priori.

ETHICS AND DISSEMINATION

Research ethics approval

The study has been approved by the Portal de Ética de la Investigación Biomédica de Andalucía Ethics Committee (1221-N-19). The trial adheres to the principles of the Declaration of Helsinki. All participants will be informed about the purpose and content of the study. Participants will also be informed that they can withdraw their consent for participation at any time during the study without penalty. Informed consent material is available in its original language (Spanish) as online supplemental appendix S5 in online supplemental file.

Safety considerations

Any adverse effects observed during the intervention or the follow-up months will be reported by the participants and researchers. If necessary, the principal investigator will ensure that the appropriate treatment for the adverse effect produced is undertaken. Additionally, adverse effects will be reported to the ethics committee.

Protocol amendments

In the event of important changes in the protocol, they will be described in subsequent publications.

Confidentiality

All study-related and participant information will be stored in locked file cabinets in areas with limited access. Data collection and forms will be identified by



a coded identification number only to maintain participant confidentiality. All records that contain names or other personal identifiers, such as locator forms and informed consent forms, will be stored separately from study records identified by code number.

Dissemination

The results of this study will be published in a relevant scientific peer-reviewed journal and will be disseminated electronically and in print.

DISCUSSION AND PERSPECTIVES

This protocol shows the methodology of an RCT designed to assess the effect of a common exercise protocol for the three predominant lower limb tendinopathies, based on an individualised control of the dose and training of specific aspects of the neuromuscular system versus the current best practice in the treatment of each of the three studied lower limb tendinopathies.

This study will provide physiotherapists directly applicable evidence about two modalities of exercise-based treatment for the management of each of the three main tendinopathies of the lower limbs. If the non-inferiority of the common experimental protocol is proved, it will provide clinicians with a tool to simplify the exercises of the exercise programmes while focusing on individualising the load progression criteria and the work of specific aspects of the neuromuscular system. Thus, this study tries to provide a progressive and generalisable standard protocol that takes into account the capabilities of the individual.

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Contributors All authors met the criteria recommended by the International Committee of Medical Journal Editors. AE-E and AIC-V formulated the idea for the study. All authors made substantial contributions to the conception and design. AE-E drafted the article. AIC-V and JC critically revised the draft for important intellectual content. All authors agreed on the final version.

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