Patellar Tendinopathy Rehabilitation – Wearable Device Feedback Mechanism

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Abstract

A patellar tendinopathy rehabilitation device has been designed and implemented to allow physical therapists to perform treatment at different inclination angles. The device is now integrated with "motivation and feedback" mechanism based on Gamification, to inform and warn the patient of potential deviations from the prescribed exercise, which may wear or damage the patellar tendon. Additionally, the device is able to record the progress of the patient against the doctor's recovery plan, providing the doctor, as well as the patient with tangible data, that they can discuss and inform further decision making. This initial work is a technology assessment and a feasibility experience of the proposed apparatus.

Introduction

The term patellar tendinopathy refers to painful overuse tendon without implying pathology; it is ideal for clinical diagnosis[1]. Chronic patellar tendinopathy is a common clinical condition that is managed by physical therapists and is common among athletes and non-athletes alike. It is most commonly characterized by pain at the inferior pole of the patella, although pain can also be at the tibial attachment, in the attachment of the tendon to the superior pole of the patella as well as mid-substance pain has been reported[1,2,3]. Patellar tendinopathy is characterized by the absence of inflammatory cells and prostaglandins and an increased presence of fibroblasts and disorganized collagen[1]. Therefore, this condition is not inflammatory as physicians had thought but is a degenerative condition. Functional activities such as squat or hop can cause pain in this condition[2,3]. However, no ideal treatment has emerged for the management of patellar tendinopathy. Nowadays, eccentric training is the most common physiotherapy treatment for patients with patellar tendinopathy[4]. To our knowledge, there have been no devices in eccentric training until recently where we have introduced a device that was designed and built to assist patellar tendon rehabilitation [5]. This work has been further improved by adding a feedback mechanism to ensure that the rehabilitation is performed within a controlled environment with/without supervision of a physiotherapist. Thus, the feedback mechanism enables self-treatment by keeping the patient within the appropriate exercise regime thus optimizing the efficacy of the exercise. Furthermore, it is cost-benefit for the training as a professional might not be required to be always present since the feedback mechanism allows the collection of data to inform further decision making experts.

Methods

The Patellar Tendon Rehabilitation Device (PTRD) was designed based on a set of requirements provided by professionals in the area of sports injuries rehabilitation specializing on knee related injuries. The device built is consisted of two metallic plates, connected together on one site allowing variable space separation between them. To achieve this, a hydraulic mechanism, was positioned inside the two plates to adjust the height between them. The level of incline, measured in degrees, is adjusted by the user (physiotherapist) through a menu and an LCD screen that the device features. To enhance the patients' rehabilitation experience, PTRD is connected to a computer via Bluetooth interface, translating the patients' exercise motions into actions in a video game.

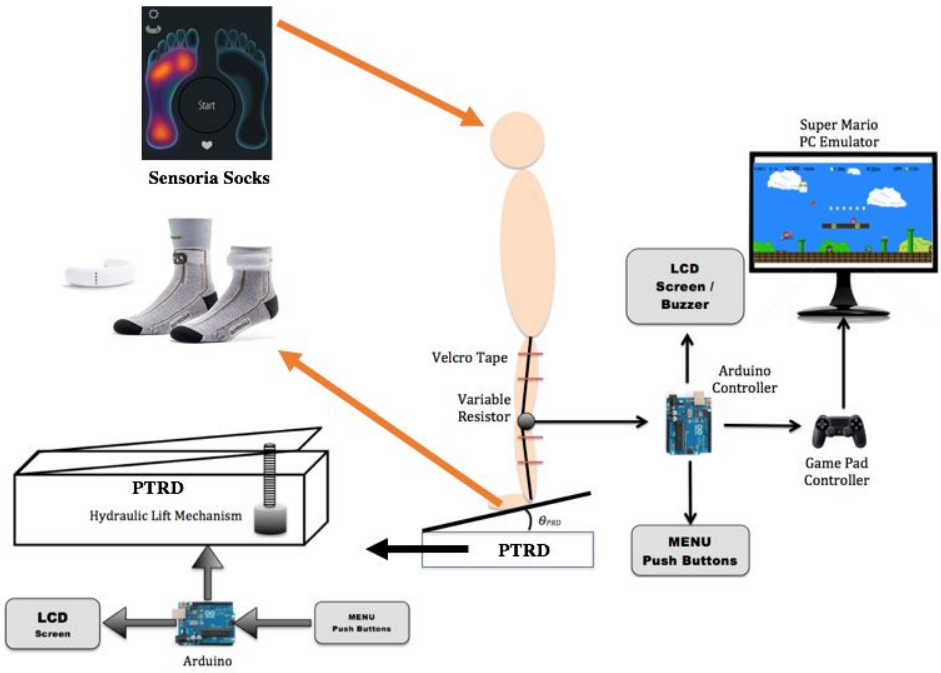

Figure 1 PTRD with Sensoria feedback mechanism

It is widely accepted that video games can be used to motivate the performance of otherwise boring behaviors and actions[6]. We performed a study to examine both the treatment and motivational characteristics of the device and we found that the treatment is at least as good as the suggested treatments for Patellar Tendon Rehabilitation. However, we found that the patients who used the device were self-reportedly more motivated and more enthusiastic about attending their rehabilitation sessions. In addition to this we have added another dimension in the existing mechanism using motivation feedback through gamification in order encourage and challenge the patient in performing the correct exercise by showing whether each step of the exercise is performed properly. As illustrated in figure 1, the feedback mechanism is based on Sensoria's textile pressure sensor technology which is infused directly in its smart socks. The socks are then connected via a Bluetooth enabled anklet to a smart device that illustrates the pressure employing the GUI available from Sensoria. Furthermore we have

setup our own type of sensor mechanism using the force sensors by flexiforce (25lbs / 1" area) in order to extract useful data from the sensor such as pressure levels, steps, sit-ups, time, etc. when performing a patellar tendon rehabilitation exercise.

Results

To evaluate our system, a controlled, monocentre trial is proposed. More specifically, the monocentre trial will be conducted in a lab setting to assess the effectiveness of an eccentric training programme for a series of inclination angles (15, 25, 35, 45 degrees). A parallel group design will be used to evaluate the effectiveness of the feedback mechanism through the result of the rehabilitation. The experiment will be performed with and without the feedback mechanism to assess its effectiveness using measures such as the Victorian Institute of Sport Assessment (VISA) score for knee function and visual analogue scale (VAS) for tendon pain with activity. Both parts have been tested and showed that they can perform the proposed clinical trial. Early results indicate that the feedback mechanism has been assisting the patients to correct their posture during the exercise while they have been motivated to maintain this posture throughout their session. The PTRD with the additional motivation and feedback mechanism provided, evaluated the effectiveness of the exercise and motivated the patient to achieve the best possible results.

Conclusions

The device has successfully implemented a number of functions that literature indicates significant benefits for the patients. The authors were able to validate the technical aspect of the implementation, as well as the accuracy of the device through a number of initial tests. Some preliminary evidence, provided by a number of patients acting as a focus group to inform the development of the device, indicates that the patient benefits from motivation and feedback with gamification. A trial study to offer more appropriate results regarding patient benefit is designed and planned for future work.

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