The Accelerated Recovery Performance (ARP) Trainer as a Method for Improving Rehabilitation Following ACL Reconstruction

+[1]Richardson, AB; [1]Tokumura, S; [2]Brusovanik, G; [2]Brown, DJ, [1]Chun, K; [1]Kikuchi, C; [1]O'Carroll, D; [1]Noh, T; [1]Burdick, D; [2]Kan, DM
[1]John A. Burns School of Medicine University of Hawaii, Honolulu, Hi [2]University of Hawaii Orthopaedic Residency Program, Honolulu, Hawaii
opihi18@gmail.com

Introduction

Atrophy of the quadriceps femoris muscle following anterior cruciate ligament (ACL) reconstruction surgery has been well documented in the literature [1, 2, 3]. The quadriceps serves as the primary stabilizer of the knee joint during translation; thus atrophy of this muscle group greatly impedes recovery following ACL reconstruction. Despite recent advancements in post-operative physical therapy, recent literature has noted a persistent quadriceps weakness and decreased cross sectional area at protracted post-operative time periods [1].

The adjunctive use of electrical stimulation has been suggested to lead to improved muscle strength and size in the post-operative period [4,5]. It has been noted specifically that rehabilitation of the quadriceps femoris following ACL surgery with the use of electrical stimulation alone is more effective than volitional exercises alone at improving gait, thigh girth, and isometric torque production about the knee [6].

The Accelerated Recovery Performance (ARP) Trainer is a high-frequency electrical-stimulation device that is used primarily in the rehabilitation of musculoskeletal injuries in athletes. Per the manufacturer, the ARP trainer, coupled with simultaneous use of a specific regimen of isometric exercises, has been purported to be capable of significantly improving muscle recovery after injury. To our knowledge, validation of the ARP trainer's ability to improve post-operational size and strength of quadriceps femoris muscle group following ACL reconstruction has not been previously performed. Therefore, the purpose of this study was to act as a pilot study to investigate the effects of the ARP trainer protocol on the rehabilitation of the quadriceps femoris after ACL reconstructive surgery.

Methods

Twenty-five patients with an isolated ACL injury and subsequent surgical reconstruction were included in this study, 14 in the experimental cohort and 11 in the control cohort. Both arms of the study received 6 weeks of traditional standard of care post-operative physical therapy prior to enrollment in the study. Once enrolled, each patient received an additional 16 sessions of physical therapy over a 6-week period. The control cohort received 6 weeks of traditional post-operative rehabilitation exercises and physical therapy. The investigational cohort received 6 weeks of the ARP trainer rehabilitation protocol.

The ARP trainer rehabilitation protocol consisted of two exercise routines utilizing a series of isometric exercises in conjunction with electromyostimulation from the ARP trainer. Two electrodes were placed over quadriceps muscle group, superiorly over the proximal muscle belly of the rectus femoris and inferiorly the distal muscle belly of the vastus medialis. The intensity of the ARP trainer was progressively increased to maximum tolerable power; determined be the patients' threshold of discomfort. Exercise routine 1 consisted of two rounds of the exercises, the first round the patient maintained position using a steady work technique (holding position while resisting gravity) and in the second round using a fast pulsation technique (repeated alternation between flexion/relaxation of the quadriceps at high frequency). The patient maintained position until failure occurred, repeating the process, after a brief period of rest, until 3 min of total work was performed. Routine 2 consisted of one round of exercises in which the patient of 10 seconds of fast pulses followed by 10 seconds of steady work. These repetitions were repeated for a total of 5 sets for each exercise.

Pre and post treatment leg circumferences served as the primary outcome measurement. The average percent difference gains of the involved limb were measured for both cohorts at 5 cm, 10 cm, 15 cm, and 20 cm above the superior patella respectively. Data was then analyzed initially with a normality test to validate the data. If the data was validated, statistical analysis proceeded with a t-test; otherwise, a Mann-Whitney Rank Sum test was utilized. Statistical significance was measured at $p < 0.05$.

Results

Significant differences in the average percent difference gains were noted between the ARP trainer cohort and those who underwent addition standard physical therapy (**Figure1**). Significant gains were noted at 5cm, 15cm and 20cm above the superior aspect of the patella, validated with t-test analysis, in the experimental cohort. Measurements of gains at 10cm above the superior patella were not validated via t-test analysis; thus, data analysis proceeded with a Mann-Whitney Rank Sum test. Using this analysis, significant difference gains were noted at the 10cm measurement as well.

The mean gain across all measurement data points for both study groups were analyzed using a t-test analysis. Validation of the summary data passed both the normality test and equal variance test. The t-test analysis resulted in a statistically significant average gains across all data points for the experimental cohort.

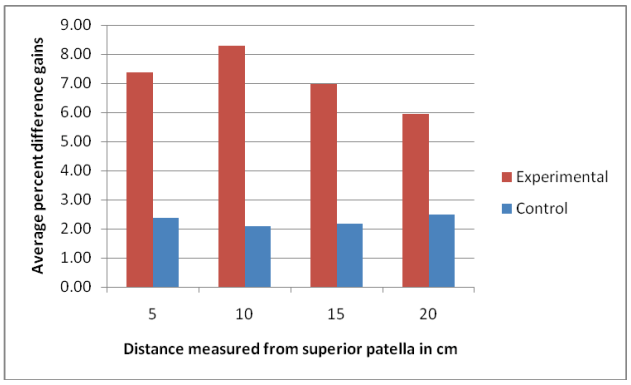

Figure 1: Average percent gains at measured sites for experimental and control groups.

Discussion

This was the first study to investigate the potential of the ARP Trainer as an adjunct to physical therapy in order to achieve superior size and strength of the quadriceps femoris muscle group. We conclude that the ARP trainer rehabilitation protocol significantly improves the rehabilitation of the quadriceps femoris in the post-operative period. The data gathered in this pilot study, demonstrates that there is a potential advantage in the use of the ARP trainer to restore strength of the quadriceps and retard disuse atrophy following ACL repair.

References:

1. Arangio GA *et al*: Thigh Muscle size and Strength After Anterior Cruciate Ligament Reconstruction and Rehabilitation. JOSPT Volume 26, Number 5, 1997
2. Gerber C *et al*: Lower extremity musculature in chronic symptomatic instability of the anterior cruciate ligament. J Bone Joint Surg 67A:1034-1043, 1985
3. Williams G *et al*: Quadriceps Weakness, Atrophy, and Activation Failure in Noncopers After Anterior Cruciate Ligament Injury. AJSM, Vol. 33 2005
4. Laughman RK *et al*: Strength changes in the Normal Quadriceps Femoris Muscle as a Result of Electrical Stimulation. Physical Therapy. volume 63. Number 4, 1983
5. Gould *et al*: Transcutaneous Muscle Stimulation as a Method to Retard Disuse Atrophy. Clinical Orthopedics and Related Research. 1982
6. Selkowitz D; Improvement in Isometric Strength of the Quadriceps Femoris Muscle After Training with Electrical Stimulation. J Physical Therapy Volume 65, 1985