COMPARISON BETWEEN TWO REHABILITATION METHODS IN THE PLANTARFLEXORS
NEUROMUSCULAR EFFICIENCY AFTER ACHILLES TENDON SUTURE

INTRODUCTION
Achilles tendon ruptures are relatively common in the adult population (1). After surgical repair, patients usually undergo a conservative or traditional (TRA) rehabilitation treatment consisting in the ankle joint immobilization for a period of 45 days. Although immobilization reduces the risk of tendon rupture, reduced use (or reduced mechanical load) in skeletal tissues leads to muscle atrophy, reduced muscle activation and reduced muscle strength. Due to these immobilization deleterious effects, studies have suggested the use of accelerated (ACC) rehabilitation programs instead of the TRA programs (2,3). The goal of early mobilization is to accelerate the healing process of the scar tissue so that it regains its ability to support loads and its ability to transfer forces between muscles and bones. Neural and muscular changes due to immobilization may change neuromuscular efficiency (NE). NE is determined through the ratio between maximal torque of synergistic muscles acting around a joint and muscle activation (4). NE has been suggested as a good index to verify neuromuscular adaptations generated by distinct functional demands. The purpose of this study was to compare NE between subjects undergoing either a TRA or an ACC rehabilitation program after surgical repair of the Achilles tendon. We hypothesize that NE will be higher in the ACC compared to that of the TRA program.

METHODS
Twenty-six male subjects with Achilles tendon rupture underwent open surgical tendon repair (Krakow technique) and were divided to either a TRA group (n=13; 41.5 ± 8.5 years of age; body mass: 81.6 ±8.8 kg) or to an ACC group (n=13; 42.8 ± 14.0 years of age; body mass: 84.4 ± 9.7 kg). Patients in the TRA group received plaster cast immobilization in the gravitational equine position for two weeks, followed by two weeks of immobilization in the same position without load. Thirty days post-surgery the patients were immobilized at neutral position for two additional weeks and load bearing was allowed with the help of crutches as tolerated. Six weeks post-surgery the plaster cast was removed and patients received training on a domiciliary exercises program. Patients of the ACC group used a removable commercially available cast positioned at neutral position. Two weeks post-surgery patients underwent six weeks of rehabilitation program, consisting of flexibility, resistance and muscle strengthening exercises. All patients were evaluated 90 days post-surgery. Plantarflexor torque was obtained with an isokinetic dynamometer (Biodex Medical System, Shirley - New York, USA). Plantarflexor peak torque was obtained with the knee extended and the hip flexed at 90°. All subjects underwent a familiarization protocol consisting of two seconds maximal isometric plantarflexor voluntary contractions at three different joint angles (-10°, 0°, 10°). After familiarization, subjects repeated the same protocol. A two minutes interval was observed between contractions to avoid possible fatigue effects. Surface electromyographic (EMG) signals (Bortec Eletronics Inc., Calgary, Canada) were obtained by passive electrodes (Ag-AgCl, Meditrace, USA) on a bipolar configuration positioned on the skin surface over the gastrocnemius medialis (GM) and soleus (SO) muscles. Skin preparation and electrodes positioning were done according to SENIAM’s recommendations. EMG signals were obtained with a sampling frequency of 2000 Hz per channel using a Windaq (Dataq Instruments Inc., Akron, USA) data acquisition system. After filtering (Butterworth 5th order, band-pass filter, 10-500 Hz), RMS values were calculated.
from the EMG signals. NE was obtained through the ratio between the maximal plantarflexor torque obtained in each ankle joint angle and the respective RMS values from each muscle (T/GM and T/SO). NE values were compared between healthy and injured sides within each group (within group comparison) and between healthy sides and between injured sides of the two groups (between groups comparison). A two-way ANOVA for repeated measures was used for comparisons (within group = healthy VS injured sides; joint angles; between groups = ACC VS TRA; joint angles). A Bonferroni post-hoc test was used to identify the differences and a 0.05 level of significance was used for all tests.

RESULTS AND DISCUSSION

Intra-group comparison revealed no difference both in SO and GM EMG activity between healthy VS injured side in the ACC group. In the TRA group there was no difference between sides for the SO activation, whereas the GM activation of the injured side was higher compared to the healthy side for all three joint angles: 10° (p=0.04), 0° (p=0.013) and -10° (p=0.02). This suggests that GM did not return to pre-injured values three months after surgery and was responsible for the differences observed in NE in the inter-group comparison (see below). When looking at EMG signals and torque separately, plantarflexor torque was similar between groups in the injured side, whereas GM activation was higher in the TRA compared to the ACC group in all three evaluated joint angles: 10° (p=0.002), 0° (p=0.001) and -10° (p<0.001). The between groups comparison revealed no difference in the healthy sides between ACC and TRA, whereas NE in GM was smaller (p<0.05) in the TRA compared to the ACC group in all three ankle joint angles (Table 1). There was no difference for NE in the SO muscle between groups for all joint angles.

Table 1: Between groups comparison for NE (mean ± SD) in the injured side 90 days post-surgery. ACC = Accelerated group; TRA = traditional group; T = torque; GM = gastrocnemius medialis; SO = soleus.

<table>
<thead>
<tr>
<th>Ankle Angle (deg)</th>
<th>NE</th>
<th>T/GM</th>
<th>T/SO</th>
<th>T/GM</th>
<th>T/SO</th>
<th>T/SO</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC</td>
<td>108±45</td>
<td>153±60</td>
<td>192±68</td>
<td>101±37</td>
<td>129±43</td>
<td>167±55</td>
</tr>
<tr>
<td>TRA</td>
<td>50±22*</td>
<td>67±27*</td>
<td>87±28*</td>
<td>88±32</td>
<td>124±48</td>
<td>134±45</td>
</tr>
</tbody>
</table>

= p<0.05 for the between groups comparison for each ankle joint angle.

The difference observed between GM and SO in the injured side between groups might be due to their different functions: biarticular VS monoarticular. Our results suggest that both muscles recovered in the ACC group, whereas the monoarticular SO muscle was able to recover faster compared to the biarticular GM in the TRA group due to its higher activation. It appears that GM increased activation was an attempt to increase force production due to a smaller NE. Neural factors are responsible for up to 80% of strength gains (5) at early stages of strength training, whereas hypertrophic factors are responsible for further gains later on during the program (6). Our results suggest that the ACC program improved the contribution of hypertrophic factors probably due to the early load applied to skeletal tissues during rehabilitation, whereas the TRA group experienced at six weeks post-surgery the early stages of rehabilitation when neural factors are still the main mechanism to improve force production. The higher GM activation in the TRA group suggest that a higher recruitment of motor units was necessary to produce similar torque at the ankle joint, thereby reducing NE in this group.

CONCLUSIONS

Patientses subjected to ACC rehabilitation programs after Achilles tendon repair showed better NE compared to that of TRA programs 90 days post-surgery.

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REFERENCES


