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## ACCELERATED REHABILITATION IMPROVES THE PLANTAR FLEXORS ARCHITECTURE AND TORQUE OF ACHILLES TENDON RUPTURE PATIENTS

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### SUMMARY

Experimental models have demonstrated that early motion of sutured tendons accelerates the return of tensile strength to the repair and reduce the restricted range of motion. This study aimed at comparing the medial gastrocnemius fascicle length (FL) and the plantarflexors torque-angle relationship (TxA) of Achilles tendon rupture patients undergoing two different rehabilitation protocols: Traditional Group (TG, n = 13; plaster cast immobilization) and Accelerated Group (AG, n = 13; early mobilization). FL and the TxA relationship (10°, 0° and -10° of plantar flexion) were measured three months post-surgery. The within-group comparison revealed smaller FL and plantarflexor torque in the operated compared to the healthy side in the TG, whereas there was no between-sides difference in FL and in torque at -10° of plantarflexion in the AG (Table 1). However, the operated side presented lower torques at 10° and 0° of plantarflexion in the AG. The between-groups comparison revealed higher torque and FL values in the operated side of AG compared to that of that of the TG. In addition, no differences were found for the healthy sides between groups. The decreased FL in the TG seems to be associated with reduced use caused by immobilization. The improvement observed in muscle architecture in the AG group was probably responsible for the smaller reduction in isometric torque in the operated side compared to that of the TG. The accelerated protocol proved to be an effective method for the early recovery of the deleterious effects of immobilization in patients with Achilles tendon rupture.

### INTRODUCTION

After surgical repair of Achilles tendon rupture, a traditional treatment (six weeks of immobilization) usually starts. However, the reduced use caused by immobilization leads to muscular and functional loss. Accelerated rehabilitation protocols have been proposed since they can determine early recovery of musculoskeletal tissues [1]. However, studies that evaluated the medial gastrocnemius morphological properties and the mechanical properties of the plantarflexor muscles [2] after complete Achilles tendon rupture post-early mobilization are scarce. Therefore, the purpose of this study was to compare the medial gastrocnemius fascicle

length (FL) and the plantarflexors torque-angle relationship (TxA) of Achilles tendon rupture patients undergoing two different rehabilitation protocols.

### METHODS

All subjects signed an informed consent form to participate in the study that was approved by the Universities Ethics in Research Committee. Twenty six male patients were allocated to two different groups according to their Achilles tendon rupture rehabilitation protocols: Traditional Group (TG, n = 13; plaster cast immobilization for six weeks) and Accelerated Group (AG, n = 13; early mobilization and use of removable orthosis). Medial gastrocnemius FL was obtained bilaterally with an ultrasound system (SSD 4000, 51 Hz, ALOKA Inc., Tokyo, Japan) and a linear array probe (60 mm, 7,5 MHz). Images were obtained at 50% of the muscle belly at rest in the approximate direction of the muscle fibers. Images were transformed into AVI format using the software BitRipper (Binotex, USA). The AVI file was tracked frame-by-frame using the Virtual Dub software (Avery Lee, USA), and the best image was selected for data analysis. A public domain NIH image program (available online at <http://rsbweb.nih.gov/ij/download.html>) was used to measure muscle architecture. FL was defined as the length of the fascicle measured between superficial and deep aponeuroses. Maximal voluntary effort was obtained isometrically at three different ankle joint angles: 10°, 0° and -10° on a Biodex isokinetic dynamometer (Biodex Medical Systems, Shirley, New York, USA). Subjects were asked to perform maximal effort as fast as possible and to maintain it for a period of at least one second before relaxing. Two-minute intervals were observed between consecutive contractions. All measurements were obtained bilaterally three months post-surgery. An independent Student t-test was used for the comparison of age, height and body mass between groups. Within-group comparison (operated x healthy sides) and between-groups comparison (TG x AG healthy sides; TG x AG operated sides) were also determined with an independent Student t-test. The level of significance adopted was p<0.05 for all tests (SPSS 17.0).

## RESULTS AND DISCUSSION

There was a reduction in FL of the operated side compared to the healthy side in TG. This reduction was not observed when comparing the AG limbs. In addition, the between-groups comparison revealed that the TG operated side had smaller FL compared to the operated side of the AG.

The operated side of TG produced smaller torques compared to the healthy side at all ankle joint angles. The same was true for the AG only for the joint angles of 10° and 0°, but not for -10°. The operated side of AG produced higher torques at all angles compared to the same side of TG.

The decrease in FL of TG seems to be associated with reduced use caused by immobilization [3]. The rehabilitation protocol promoted the return of FL to similar values of those of the healthy side in AG.

In addition, the rehabilitation program was also successful in producing partial recovery of the torque production capacity of the plantar flexors, as torque values of the operated side of AG were higher than those of the TG. However, the fact that the torque of the operated side of the AG were smaller compared to the healthy side of this group in two of the three ankle angles studied is evidence that full recovery in torque production was not obtained. This was probably due to the short duration of the protocol (six weeks) and to the fact that the emphasis of our accelerated rehabilitation protocol was on gaining flexibility and increasing the ankle joint range of motion, and not in increase in strength. We suggest that longer rehabilitation protocols are needed in

order that force production can be included as a second emphasis in the protocol, which will allow for the full recovery of torque production in patients post Achilles tendon rupture.

## CONCLUSIONS

The accelerated protocol improved muscle architecture and reduced the loss in plantiflexor torque, showing evidence that it is an effective method for the early recovery from the deleterious effects of immobilization and of the Achilles tendon rupture.

## ACKNOWLEDGEMENTS

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Table 1. Gastrocnemius medialis fascicle length and torque (normalized by body weight) values (mean and standard deviation) of the traditional group (TG) and accelerated group (AG).

Angle joint	TG (n=13)		AG (n=13)	
	Healthy	Operated	Healthy	Operated
	<b>Torque (Nm/BW)</b>		<b>Torque (Nm/BW)</b>	
10°	1.35 ± 0.12	0.74 ± 0.06*#	1.45 ± 0.11	1.05 ± 0.09*
0°	1.69 ± 0.14	0.98 ± 0.08*#	1.83 ± 0.13	1.42 ± 0.10*
-10°	2.00 ± 0.16	1.20 ± 0.10*#	2.05 ± 0.16	1.76 ± 0.11
	<b>Fascicle Length (mm)</b>		<b>Fascicle Length (mm)</b>	
0°	49.06 ± 6.28	39.98 ± 4.91*#	53.62 ± 6.77	48.24 ± 7.97

\* indicate difference (p<0.05) between healthy and operated side (within-group comparison). # indicate difference (p<0.05) between operated sides (between-groups comparison).