

# ISOKINETIC PLANTAR FLEXION TORQUE INCREASES AFTER OPEN GASTROCNEMIUS RECESSION

<sup>1</sup> Nicole Chimera, <sup>2</sup>Mike Castro and <sup>1</sup>Kurt Manal

<sup>1</sup>Center for Biomedical Engineering Research, University of Delaware, Newark, DE,

<sup>2</sup>Center for Orthopedic Research & Education, Phoenix, AZ

email: [manal@udel.edu](mailto:manal@udel.edu), web: [www.cber.udel.edu](http://www.cber.udel.edu)

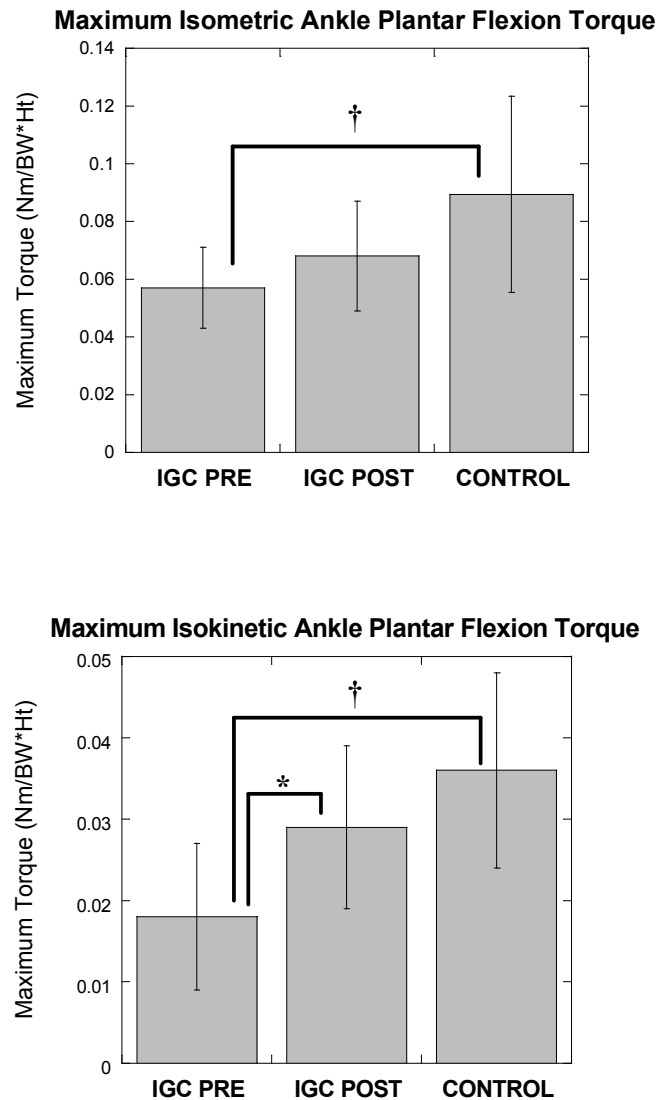
## INTRODUCTION

The amount of force developed by a muscle is related to many factors including where the muscle operates on its length-tension curve. It is well documented that placing the triceps surae muscle group in a lengthened state (i.e.: near maximal dorsiflexion) elicits maximum plantar flexion torque [1, 2]. Isolated gastrocnemius contracture (IGC) is characterized by limited dorsiflexion with the knee extended [3], and thus patients with IGC may exhibit plantar flexion strength deficits as a consequence of their reduced range. The ability to generate sufficient torque at the ankle and at the appropriate time is important for normal gait.

Increased range of motion, and thus triceps surae length can be achieved through surgery. Gastrocnemius recession is a surgical procedure in which the gastrocnemius tendon is incised; however the effect that this procedure has on plantar flexion torque generation is not known. The purpose of this study was to evaluate plantar flexion strength in patients with IGC pre and post open gastrocnemius recession surgery. We hypothesized that pre-operative plantar flexion strength would be less than healthy controls. Further, we hypothesized that gastrocnemius recession surgery would increase dorsiflexion range of motion and because of this increased range patients would be stronger compared to pre-operative plantar flexion torque. However post-operative plantar flexion would still be less than healthy control subjects.

## METHODS

7 legs clinically diagnosed with IGC were matched for gender, age, weight, and height with healthy control subjects from a database of 35 subjects recruited from the local area. IGC was defined as less than 0° of passive ankle dorsiflexion with the



**Figure 1:** Peak isometric and isokinetic plantar flexion torques PRE and POST surgical recession compared to control subjects.

\* IGC PRE significantly different from IGC POST

† IGC PRE significantly different from CONTROL

knee in full extension. Control subjects had normal ankle range of motion. IGC subjects were tested prior to surgery and 3 months post-operative. Control subjects were tested only once. A bi-plane goniometer was used to measure dorsiflexion range of motion.

The Biodex was used to measure maximal isometric and isokinetic (60°/sec) ankle plantar flexion force production. Three trials of isometric and isokinetic plantar flexion contractions were performed with maximum ankle dorsiflexion while the knee was placed in full extension.

The trial which elicited the peak isometric and isokinetic ankle plantar flexion torques were used for comparison. The torque signal was passed through a moving average window in a custom Lab View program, and the peak was calculated after limb weight, foot plate weight, and the passive moment were taken into account. Torque was normalized to body weight and height to account for strength differences known to occur between people of different sizes.

Wilcoxon signed rank and Mann-Whitney U exact tests were used to compare between and within subjects, respectively. An alpha level of  $p < 0.05$  was used to identify statistical significance for dorsiflexion range of motion, peak isometric plantar flexion torque, and isokinetic plantar flexion torque.

## RESULTS AND DISCUSSION

Dorsiflexion range of motion significantly improved following gastrocnemius recession surgery; there were no differences in group demographics (Table 1). Peak isometric and isokinetic plantar flexion torque were significantly

lower for pre-surgical IGC subjects compared to controls (Figure 1). Isokinetic plantar flexion torque increased significantly post-surgically. Although not statistically different, isometric plantar flexion strength also increased post-operatively.

## CONCLUSIONS

Gastrocnemius recession surgery restored normal dorsiflexion range of motion in our group of subjects. It also allowed for increased plantar flexion torque, presumably a result of the muscle working on a more favorable portion of the length tension curve. Plantar flexion torque increases with increased ankle dorsiflexion while the Achilles tendon moment arm decreases [4]; therefore increased torque is likely associated with improvements along the length-tension curve. Post-operative plantar flexion torque however was still less than control subjects. We suggest that post-operative strength training would be ideal for these subjects.

## REFERENCES

1. Fugl-Meyer A, et al. *Acta Physiol Scand* **107**, 47-56, 1979.
2. Sale D, et al. *J Appl Physiol* **52**, 1636-42, 1982.
3. Silfverskiold N. *Acta Chir Scand* **56**, 315-330, 1924.
4. Magnaris CN, et al. *Eur J Appl Physiol* **83**(4-5), 363-369.

## ACKNOWLEDGEMENTS

Synthes, Inc.

**Table 1:** Average group demographics and dorsiflexion range of motion.

	Gender	Age years (SD)	Height m (SD)	Weight kg (SD)	DF ROM ° (SD)
<b>IGC PRE</b>	♀ = 6; ♂ = 1	50.6 (2.1)	1.7 (.07)	83.8 (6.8)	-1 (1)* †
<b>IGC POST</b>	SAME	51.3 (1.7)	SAME	83.6 (6.7)	13 (5)
<b>CONTROL</b>	♀ = 6; ♂ = 1	49.4 (5.5)	1.7 (.11)	76.1 (10.5)	14 (8)

SAME indicates IGC POST is unchanged from IGC PRE

\* IGC PRE significantly different from IGC POST

† IGC PRE significantly different from CONTROL