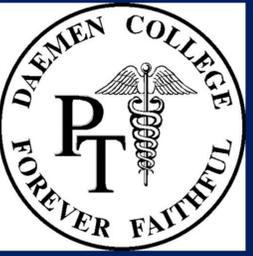


# Effectiveness of Electrical Muscle Stimulation on Regaining Muscle Strength Post-Operation

Erin Kwiatkowski SPT, Christian Kyles SPT, Amanda Lauricella SPT, Mark Lukomskiy SPT  
 Research Advisor: Michael Brown, PT, DPT, OCS, Cert. MDT, COMT, CSCS, FAAOMPT  
 Daemen College Department of Physical Therapy



## Purpose

Does the literature support electrical muscle stimulation (EMS) as an appropriate physical agent to aid in regaining muscle strength post-operation? This review of the literature will discuss the research behind the efficacy of EMS on regaining muscle strength post-operation.

## Background

After surgery patients move to a rehabilitation program, which forces them to move not only through post-operative pain, but initiate movement using muscles that have most likely atrophied due to immobilization as well as a deficit in reflex inhibition to a greater extent than before surgery. When used in early rehabilitation, electrical muscle stimulation is able to improve range of motion secondary to pain. It potentially mitigates muscle voluntary activation deficits and prevents muscle atrophy when used early after surgery. This allows normal muscle strength and function to return at a faster rate compared to just manual exercise rehabilitation alone.

## Typical Parameters for Muscle Strength

Parameter	Numerical Value
<b>Pulse Frequency</b>	35-80pps (Hz)
<b>Pulse Duration</b>	150-200 µsec for small mm. 200-350 µsec for large mm.
<b>Output Intensity</b>	To>10% of MVIC in injured mm. To>50% of MVIC in uninjured mm.
<b>On:Off times/ratio</b>	6-10 sec on, 50-120 sec off, ratio of 1:5
<b>Ramp Time</b>	At least 2 sec
<b>Treatment Sequence</b>	10-20 minutes to produce 10-20 contractions every 2-3 hours

Table 1: These are typical parameters for EMS that are used by clinicians with the intent of increasing strength of a muscle.<sup>5</sup>

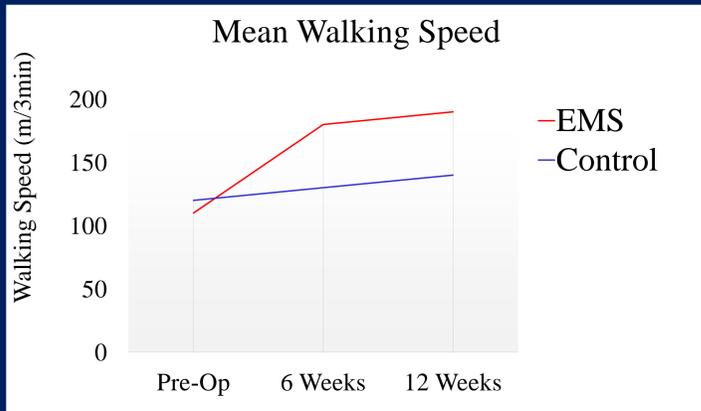


Figure 1: The mean walking speed of subjects who received EMS and PT post-operation vs subjects who received just PT post-operation. The mean walking speed was recorded at pre-operation for baseline, 6 weeks post-op, and 12 weeks post-op. The results suggest EMS can improve subjects' walking speed.<sup>1</sup>

## Literature

Study	Subjects	Exercise Intervention	Results
Avramidis K, Strike P, Taylor P, Swain I <sup>1</sup> 2003	- 30 subjects - Mean age 69-71 years of age  - Inclusion criteria: Unilateral knee OA	Subjects divided into two groups  Group 1: EMS and PT Frequency: 40 Hz Pulse width: 300 µs Intensity: max tolerable level by each subject Treatment time: twice daily for 2 hours each Duration: 6 weeks Standard PT Protocol (listed below)  Group 2: Standard PT Protocol CPM machine Static quadriceps exercises Active flexion and extension exercises Heel slides Progress to increasingly more difficult exercises Activities of daily living	-Statistical significance between groups when comparing walking speed  -No statistical significance between groups when comparing Physiological Cost Index and Hospital for Special Surgery knee scores  Conclusion: The application of EMS, supplementing conventional PT, can improve the walking speed of subjects recovering from a total knee arthroplasty, particularly in subjects with significantly weakened quadriceps
Hasegawa S, Kobayashi M, Arai R, Tamaki, A Nakamura T, Moritani T <sup>2</sup> 2011	- Twenty subjects (16 male, 4 female) - Age range 13-54 years  - Inclusion Criteria -acute ACL tear with arthroscopic assisted semitendinosus autograft reconstruction	Subjects divided into 2 groups  Group 1: Control -Usual rehabilitation program  Group 2: EMS -Usual rehabilitation program -Handheld muscle stimulator with 15-V battery - Frequency: 20 Hz - Pulse width: 250µs -Duty cycle: 5s stimulation with a 2 s pause for a 20 min period - Treatment time: 5 days a week - Duration: 4 weeks	-Statistical significance shown in comparing the decrease of quadriceps peak torque at 4 weeks post-op  -Recovery in EMS group was higher than in the CON group at 3 months  -Muscle strength difference between the two groups at 3 months post-op  Conclusion: The application of EMS if implemented during the early rehabilitation stage is effective in maintaining and changing the thickness and muscle strength of the quadriceps and hamstring muscles in the operated limb.
Stevens-Lapsley JE, Balter JE, Wolfe P, Eckhoff DG, Kohrt WM <sup>3</sup> 2012	- 66 subjects - Ages 50-85  -Inclusion criteria: -50-85 - Tricompartmental, cemented TKA with a medial parapatellar surgical approach	Subjects divided into 2 groups  Group 1: -Standard rehabilitation program  Group 2: EMS -Standard rehabilitation program -Initiated 48 hrs after TKA -Portable EMPI 300PV - Most tolerable intensity for 15 contractions -Twice a day -Duration: 6 weeks	-Statistical significance between EMS group and control group in quadriceps and hamstring muscles strength at 3.5 weeks post-op and 52 weeks post-op  Conclusion: EMS along with standard rehabilitation protocol is an effective method of limiting muscle strength loss, ROM loss, and maintaining functional abilities after a TKA.
Reinold MM, Macrina LC, Wilk KE, Dugas JR, Cain EL, Andrews JR <sup>4</sup> 2008	- 39 subjects - Age range 23-76 (Average 54)  - Inclusion criteria: -Underwent surgery of the supraspinatus tendon -37 underwent arthroscopic procedure, 2 had mini-open procedure	Subjects divided into two groups  Group 1: Control -Usual rehabilitation program  Group 2:NMES -Subject supine shoulder in 45 degrees of abduction, neutral rotation and 15 degrees of horizontal adduction -NMES to the infraspinatus muscle with EMPI 300 PV unit. -Frequency 50 pulses per second -Asymmetrical wave form -300 microsecond pulse length -Performed 3 isometric contractions of ER into a dynamometer	-Peak force production showed a statistically significant increase in force production by 22% (P<0.05) in the group that received NMES  -No statistically significant difference between groups when broken down by age, gender, size of tear, days after surgery, or electrical stimulation intensity  Conclusion: Use of NMES in early stages of rehabilitation process are recommended to restore muscle strength by aiming to prevent deleterious effects of pain, effusion and muscle inhibition

## Conclusion

According to the literature reviewed, electrical muscular stimulation (EMS) effectively assists in the treatment of postoperative patients. Specifically, the research concluded that postoperative patients treated with EMS along with standard rehabilitation protocol experienced decreased muscle atrophy, decreased strength loss, and increased functional abilities compared to groups only treated by standard rehabilitation protocol.

## Future Research

Each study involved different parameters regarding the level of EMS being applied to the subjects. These parameters varied from the commonly accepted parameters used by most clinicians; however, each study supported the use of EMS as an effective physical agent to aid in regaining muscle strength post-operation. Due to these findings, further research is necessary to determine if different parameters should be considered when applying EMS to patients.

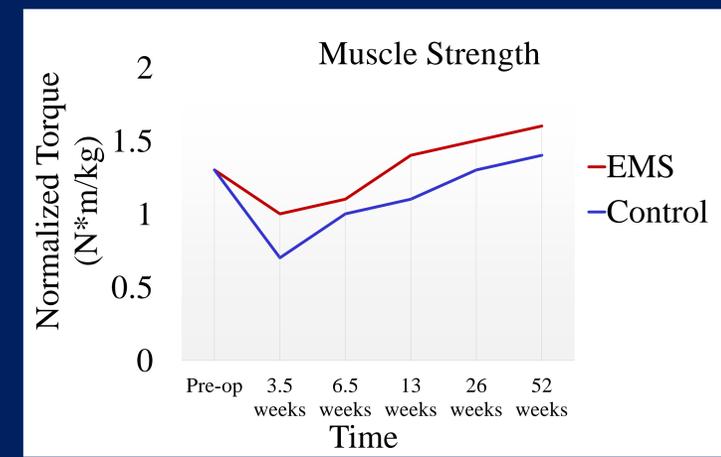


Figure 2: The average muscle strength in subjects who received EMS and PT vs subjects who received just PT post-operation. Strength was measured pre-op, at 3.5 weeks post-op, 6.5 weeks, 13 weeks, 26 weeks, and 52 weeks.<sup>3</sup>

## References

- Avramidis K, Strike PW, Taylor PN, Swain ID. Effectiveness of electric stimulation of the vastus medialis muscle in the rehabilitation of patients after total knee arthroplasty. Arch Phys Med Rehabil. 2004;84(12):1850-3. doi:10.1016/S0003-9993(03)00429-5.
- Hasegawa S, Kobayashi M, Arai R, Tamaki A, Nakamura T, Moritani T. Effect of early implementation of electrical muscle stimulation to prevent muscle atrophy and weakness in patients after anterior cruciate ligament reconstruction. J Electromyography Kinesiology. 2011;21(4):622-30. doi:10.1016/j.jelekin.2011.01.005.
- Stevens-Lapsley JE, Balter JE, Wolfe P, Eckhoff DG, Kohrt WM. Early neuromuscular electrical stimulation to improve quadriceps muscle strength after total knee arthroplasty: a randomized controlled trial. Phys Ther. 2012;92(2):210-226. doi:10.2522/ptj.20110124.
- Reinold MM, Macrina LC, Wilk KE, Dugas JR, Cain EL, Andrews JR. The effect of neuromuscular electrical stimulation of the infraspinatus on shoulder external rotation force production after rotator cuff repair surgery. Am J Sports Med. 2008;36(12):2317-2321. doi:10.1177/0363546508322479.
- Cameron MH. Physical Agents in Rehabilitation from Research to Practice, 2012. Cited by: Stachura J, Bringing Physical Agents To Life Through Laboratory Experiences (Inquiry Based Learning, 2018; pg. 99.