Preoperative Quadriceps Femoris Neuromuscular Electrical Stimulation in Patients Undergoing Total Knee Arthroplasty

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INTRODUCTION

Quadriceps femoris muscle (QFM) weakness has been implicated in the development of knee osteoarthritis (OA) as well as predicting functional ability after total knee arthroplasty (TKA).(1,2) The putative mechanisms responsible for QFM weakness include sarcopenia, disuse atrophy, and a negative ntrogen balance, however the principle factor is considered to be arthrogenic muscle inhibition.(2)

Neuromuscular electrical stimulation (NMES) devices apply transcutaneous electrical current to the neuromuscular junction and surrounding muscle fibres causing muscle contraction by circumventing the neural inhibition feedback loop. As a rehabilitation tool, NMES has been shown to reduce extensor lag, length of hospital stay, and significantly improve walking speed 12 weeks after knee surgery.(3,4) However preoperative strengthening (prehabilitation) using NMES has not been investigated.

AIMS

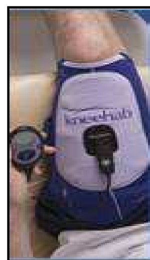
To determine the efficacy and compliance of a home-based NMES prehabilitation programme in restoring QFM strength and improving knee function in a cohort undergoing total knee arthroplasty

METHODS

Sixteen patients (10 women and 6 men) were recruited and randomised (single blind) into a control (n=6) or intervention (n=10) group.

	Intervention (A)	Control (B)
Total Subjects	10	6
F:M	6:4	4:2
Age	61.8 +/-9.0	65.5 +/-6.8
BMI	33.2 +/-5.6	29.7 +/- 2.1

NMES was applied to the affected QFM using a portable garment based stimulator (Kneehab II, Bio-Medical Research, Galway, Ireland) for 20 min/day, 5 d/wk for 8 weeks. The initial 2 weeks facilitated familiarisation of the patients with the device and to adjust stimulation intensity until an effective level was achieved.



Isokinetic and isometric QFM strength were determined at baseline, week 2, week 5 and week 8 using a Biodex dynomometer. Knee function was assessed using a 25 metre timed walk test (TWT), timed stair-climb test (SCT), and timed chair-rise test (CRT) at baseline and week 8 (pre-op).

Subjects in the intervention group recorded the duration and maximal stimulation intensity of each session in a log book. In addition, and unknown to participants, the Kneehab II software also recorded and stored the total treatment time and average stimulation intensity.

Statistical analysis was performed using ANOVA and independent t-test's where appropriate.

RESULTS

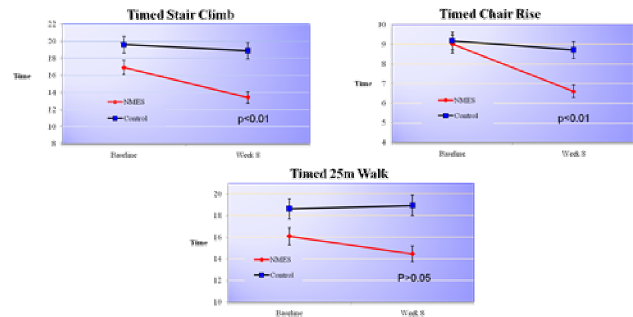


Figure 1. Knee Functional Assessments at Baseline and Pre-op (Week 8)

Timed SCT decreased from 16.9 sec to 13.4 sec ($p<0.01$), and the timed CRT decreased from 9.0 sec to 6.6 sec. ($p<0.01$) in the NMES group at week 8 compared to week 0.

Isometric QFM strength was significantly higher in the NMES group at weeks 2, 5 and 8 than week 0. Compared to week 0, isokinetic hamstring strength increased significantly in the NMES group at week 2, week 5 and week 8 5 and isokinetic QFM strength increased at week 5 ($p<0.05$) and week 8 ($p<0.01$).

Patient recorded compliance was 99.5% (range, 97.1%-100%). The overall usage recorded on the stimulator was variable ranging from 69.7% to 114.8% (96.1% ± 13.2; mean ± SD).

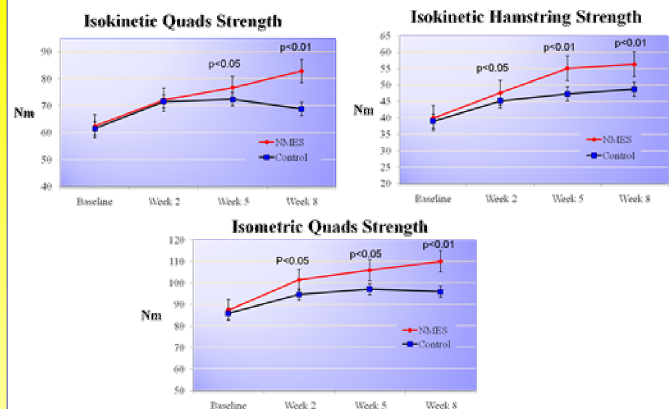


Figure 2. Isokinetic and Isometric Strength (Peak Torque)

CONCLUSIONS

The use of a portable home-based NMES program for 8 weeks resulted in significant preoperative improvements in QFM strength and knee function in patients undergoing TKA compared to controls. The compliance rate was excellent.

NMES may have a role where patients are unable to participate in a standard preoperative exercise-based program. Further considerations for NMES include its application in younger patients as a temporising therapy delaying an inevitable TKA, or as part of definitive therapy where surgery is contraindicated or declined by a patient, although further study is required.

1. **Slemenda C, Brandt KD, Heilman DK, et al.** Quadriceps weakness and osteoarthritis of the knee. Ann Int. Med. 127:97-104, 1997
2. **Mizner RL, Petterson SC, Stevens JE, et al.** Early quadriceps strength loss after total knee arthroplasty. J Bone Joint Surg. Am. 87:1047-1053, 2005
3. **Gotlin RS, Hershkowitz S, Juris PM, et al.** Electrical stimulation effect on extensor lag and length of hospital stay after total knee arthroplasty. Arch Phys Med Rehab. 75:957-959, 1994
4. **Avramidis K, Strike PW, Taylor PN, et al.** Effectiveness of electrical stimulation of the vastus medialis muscle in the rehabilitation of patients after total knee arthroplasty. Arch Phys Med rehab. 84:1850-1853, 2003