

Electrical Stimulation of Vastus Medialis in the rehabilitation of patients undergoing total knee arthroplasty

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Introduction

It is well established that quadriceps weakness is evident early in knee osteoarthritis and, along with pain, is one of the earliest clinical symptoms reported by patients. Electrical muscle stimulation has been reported to effectively improve the functional capacity of the quadriceps [1,2] and attenuate the muscle atrophy associated with total knee arthroplasty [1,3]. In this study EMS of the vastus medialis of patients recovering from TKA was applied in addition to the standard rehabilitation programme in an attempt to: (a) investigate a possible effect on their walking speed, HSS functional knee score and PCI in the immediate post-operative period (b) assess whether a “carry over effect” on the same parameters existed 6 weeks after its termination.

Methods

This study was a prospective, randomised control trial conducted in a Department of Orthopaedics and a Department of Medical Physics and Biomedical Engineering of a District General Hospital, having first obtained approval from the local Ethics and Research & Development committees.

Consecutive patients suffering from unilateral osteoarthritis of the knee admitted for elective primary TKA were recruited, until 30 had completed the study. Table-1 provides demographic data on the participants. Patients were randomly assigned to two equal groups (n=15). All patients received the same cemented prosthesis (AMK-DePuy), inserted through a medial parapatellar arthrotomy. Post-operatively both groups received the same amount of conventional physiotherapy and, in addition, the Treatment group received transcutaneous EMS of the vastus medialis for the first 6 weeks.

Starting from the second postoperative day, EMS (40Hz, 300µs) was applied twice daily, for 2h on each occasion, while the patient was sitting or lying in bed with the knee extended. The stimulator used was the Microstim two channel (MS-2) neuromuscular stimulator (Department of Medical Physics and Biomedical Engineering, Salisbury District Hospital, UK). The performance of the knees was assessed by the use of HSS knee scoring system pre-operatively and at 1, 6 and 12 weeks after the TKA. Measurements of the walking speed and PCI score of the patients were obtained pre-op and at 6 and 12 weeks post-op. Differences between the control and treatment groups in respect of mean outcomes at 6 and 12 post-operative weeks were assessed after baseline adjustment using parametric analysis of covariance (ANCOVA) and confirmed by a robust ANCOVA.

Results

Results are summarized in Table 2. The mean values at 6 and 12 weeks are the baseline adjusted ANCOVA values. Comparing the Treatment and Control groups we found no

AGE	Number	Mean age	SD
EMS	15	68.20	10.59
Control	15	71.20	7.83
GENDER		Male	Female
EMS	5	10	
Control	3	12	

TABLE - 1: Demographic data of the participants

statistically significant treatment effects for the PCI or the HSS knee-score outcome variables. A highly significant treatment effect was observed for walking speed at both 6 weeks ($p=0.0002$) and 12 weeks ($p<0.0001$) post-op, Figure 1. Both P-values are well below the Bonferroni adjusted 5% significance threshold of 0.008 and the adjusted 1% threshold of 0.0017. Confidence intervals (95%) on the increase in walking speed at both 6 weeks (12.6 to 36.2 m in 3 min) and 12 weeks (20.9 to 43.9m in 3 min) suggest a treatment effect of real value to the patient.

	Walking Distance (m) (3 min walk)			PCI Heart beats/m			HSS Knee score		
	0	6	12	0	6	12	0	6	12
Weeks post-op									
Controls	135.5	151.7	155.9	0.48	0.40	0.35	62.4	76.4	81.2
EMS-group	140.6	176.1	188.2	0.49	0.40	0.37	58.1	79.5	84.7
Difference		24.4	32.3		0.00	0.02		3.1	3.5
95% ci		12.6 to 36.2	20.9 to 43.9		-0.06 to 0.06	-0.08 to 0.04		-2.9 to 9.1	-2.4 to 9.4
P-value		0.0002	<0.0001		>0.20	> 0.20		> 0.20	> 0.20

Table 2 Results of walking speed, PCI and HSS knee score

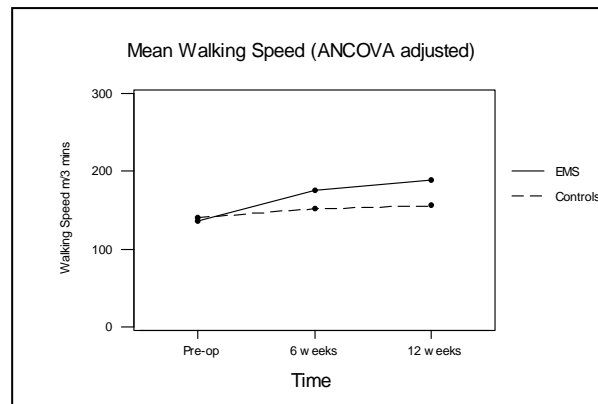


Figure 1 Walking speed comparing controls and treatment groups

Conclusion

Patients with severe osteoarthritis (OA) of the knee requiring TKA have significant neuromuscular disease in the quadriceps muscle consisting of generalised atrophy of both type-I and type-II fibres. The study of Martin et al [4], although conducted on a limited sample, demonstrated EMS to be highly beneficial for maintenance of muscle mass in individuals with OA recovering from TKA. Furthermore, rehabilitation of these patients by the use of EMS in combination with physiotherapy can reduce knee extensor lag and decrease the length of their hospital stay [4]. Eriksson, also suggested EMS of the quadriceps as an effective way of preventing muscle atrophy after major knee ligament surgery in athletes [5].

In our study we selected to stimulate the vastus medialis muscle, being aware of the important influence of this part of the quadriceps upon gait performance and motor control of the knee. Our findings demonstrate that the clinical application of EMS of the vastus medialis supplementing conventional physiotherapy can improve the walking speed of the Orthopaedic patients recovering from TKA and increase their ability to participate in the exercise programme. A definite “carry over” effect was recorded 6 weeks after termination of EMS, indicating a sustained improvement in locomotion performance. We believe this mode of treatment could be used to expedite the rehabilitation process following TKA, particularly in those patients with significant quadriceps weakness.

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Suppliers

The Microstim 2 is CE marked and available to clinicians from the Department of Medical Physics and Biomedical Engineering, Salisbury District Hospital, Salisbury, Wiltshire, SP2 8BJ. (www.salisburyfes.com)

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