



ISB 2013
BRAZIL

XXIV CONGRESS OF THE INTERNATIONAL
SOCIETY OF BIOMECHANICS

XV BRAZILIAN CONGRESS
OF BIOMECHANICS

EFFECTS OF A 12-WEEK NEUROMUSCULAR ELECTRICAL STIMULATION HOME-BASED PROGRAM ON TORQUE PRODUCTION, FUNCTIONAL CAPACITY AND QUALITY OF LIFE OF ELDERLY WOMAN WITH KNEE OSTEOARTHRITIS

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SUMMARY

Introduction: Muscle weakness is one of the early symptoms of patients with knee osteoarthritis (OA). Neuromuscular electrical stimulation (NMES) may decrease muscle weakness in these patients. The purpose of this study was to evaluate the effect of a 12-week domiciliary NMES program on torque production, functional capacity, physical activity and quality of life of elderly women with knee OA. **Material and Methods:** Eight women (64.1 ± 8 years) underwent a 12-week home-based NMES program. Maximal isometric and dynamic torques were evaluated through an isokinetic dynamometer. Functional capacity was evaluated with the Time Up-and-Go test. Quality of life was assessed using the WOMAC questionnaire. **Results:** There were no changes in the isometric torque values obtained at different joint angles ($p=0.857$) nor in the dynamic torque values obtained at different angular velocities ($p=0.857$) from pre-NMES to post-NMES. There was an improvement in functional capacity ($p=0.008$). There were no changes in pain ($p=0.117$) and stiffness ($p=0.190$), while there was improvement in disability ($p=0.049$) as accessed by the WOMAC questionnaire. **Conclusion:** A 12-week home-based NMES program produced an improvement in physical capacity and in the ability to perform daily life activities with no changes in maximal torque, in elderly women with knee OA. **Keywords:** Knee, Osteoarthritis, Torque, Neuromuscular Electrical Stimulation.

INTRODUCTION

Muscle weakness is one of the early symptoms of patients with knee osteoarthritis (OA) [1]. A previous study from our group revealed that patients with knee OA have lower capacity of isometric and dynamic torque production when compared to elderly asymptomatic for OA [2]. Neuromuscular electrical stimulation (NMES) has been used for strength training [3,4] and may counteract the deleterious effects of OA. In addition, some studies have shown that NMES increases the torque production capacity of the knee extensor muscles and the quality of life of elderly patients with knee OA [5,6,7,8].

The purpose of this study was (1) to evaluate the effects of a 12-week home-based NMES strengthening program on (1)

ability to generate torque, (2) functional capacity, and (3) quality of life in patients with knee OA.

METHODS

Eight female subjects with a mean age of 64.1 ± 8 years (mass= 79 ± 16.2 kg and height= 1.6 ± 0.07 m), who were clinically diagnosed with grades 2 and 3 of knee OA (based on the criteria from Kellgren & Lawrence) were subjected to 12 weeks of progressive NMES strength training performed at home.

Figure 1: Electrical stimulator used for the home-based



NMES strengthening program.

Subjects received a portable specially designed elderly friendly electrical stimulator (Figure 1). The device was pre-programmed by the researchers to carry out the 12 weeks NMES program. The device emitted a symmetrical biphasic current with a frequency of 80 Hz and pulse width of 400 ms, which was applied in the form of pulse trains of 10 s duration. To avoid fatigue effects, a 50 s interval was given between contractions at the start of treatment. For proper

progression of mechanical overload generated by electrical stimulation, the session time duration was increased by two minutes every week, while the time interval between pulse trains was reduced by 10 sec every three weeks. Two daily sessions of treatment were applied, with a frequency of three times a week. The participants were instructed to perform all sessions in the sitting position with the knee flexed at 90° and the ankle fixed to the chair by a special band, avoiding any joint movement during the electrically elicited contractions. The stimulation intensity was always the maximum tolerated by the participants.

The maximum knee extensor isometric torque was accessed with the Biodex System 3 Pro dynamometer (Biodex Medical Systems, Shirley - NY, USA). To evaluate the torque-angle relationship, subjects performed maximal knee extensor voluntary isometric contractions (MVIC, five seconds duration) at four different joint angles: 60°, 75°, 90° and 105° (full knee extension = 0°). The torque-velocity relationship was obtained with three maximal voluntary concentric contractions (MVCCs) performed at the angular velocities of 60°/s, 120°/s, 180°/s and 240°/s. The execution order was determined randomly, with two-minute rest between consecutive tests. The torque-angle relationship was determined from the absolute maximum torque achieved at each of the tested angles. For the torque-velocity relationship only the largest peak torque achieved during contractions was used. With the peak torque values obtained for each subject, mean and standard deviations were calculated for each contraction type. All data were normalized by the mean MVIC in order to enable proper comparison among subjects.

Functional capacity was determined with the Time Up-and-Go test. The change in functional capacity of participants was assessed by comparing the time required to perform the test before and after the NMES training program. The time was measured using a digital chronometer manually operated.

To assess the quality of life, subjects answered the Western Ontario and McMaster Universities (WOMAC) questionnaire, which is a specific instrument for assessing quality of life in patients with OA.

Data normality was evaluated with the Shapiro-Wilk test, followed by the Levene test to verify data sphericity. Data comparison between the pre and post-training was done for isometric torque and dynamic torque through a two-way analysis of variance. For comparison of quality of life and functional capacity between pre- and post-training, a paired Student t-test was used. In case of non-parametric data, the Wilcoxon test was used. All analyses were performed with SPSS software (version 18.0 for Windows) with a significance level of 5% ($\alpha \leq 0.05$).

RESULTS AND DISCUSSION

No differences were found between pre- and post-training values for isometric torque at knee angles of 60°, 75°, 90° and 105° ($p=0.857$). Also, no differences were found between pre- and post-treatment for peak torque values at the angular velocities of 0°/s, 60°/s, 120°/s, 180°/s and

240°/s ($p=0.971$). No differences in mean scores for the domains of pain ($p=0.117$) and joint stiffness ($p=0.190$) were observed between pre- and post-training. However, there was an average reduction of 34% of the inability to perform daily-life activities ($p=0.049$). In addition, there was an average reduction of 9% in the time to perform the Time Up-and-Go functional test after the 12-week NMES home-based training program ($p=0.008$).

The present study aimed at examining the effects of a 12-week progressive home-based NMES strength training program on the quadriceps muscle mechanical properties, on the functional capacity and on the quality of life of elderly women with knee OA. Talbot et al. [8] also evaluated the effects of a 12-week home-based knee extensor NMES program applied to elderly OA patients. After training performed at an average intensity of 22% of the MVC of each subject, there was a 9% increase in knee extension torque. In our study, the stimulation intensity used was the highest tolerated by the subjects, which might have been lower than that of Talbot et al [8], and may explain why no changes were observed in the torque production capacity.

Durmus et al. [6], after only four weeks of NMES training, observed improvements in the degree of pain, stiffness, as well as in functional capacity. Walls et al. [7] observed an increase in performance of functional tests after six weeks of NMES. In the present study, although no changes were observed in the torque production capacity, there was a 15% reduction in time to perform the Time Up-and-Go functional test. Moreover, although no improvement was observed in the levels of pain and joint stiffness, we found a 34% improvement in the ability to perform daily-life activities.

CONCLUSIONS

The 12-week progressive NMES home-based training program did not improve the torque production capacity, but improved physical capacity and quality of life of elderly women with knee OA.

ACKNOWLEDGEMENTS

The authors would like to thank FINEP-Brazil and CNPq-Brazil for financial support, and the elderly patients who agreed to participate in this study.

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