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ORIGINAL ARTICLE

Dexterity Training Improves Manual Precision in Patients Affected by Essential Tremor

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Abstract

Objective: To evaluate the effect of a short-term dexterity-training program on muscle tremor and the performance of hand precision tasks in patients with essential tremor (ET).

Design: Three testing sessions: baseline, after 4 weeks without any interventions (control), and after 4 weeks of dexterity-training carried out 3 times per week.

Setting: Biomechanics research laboratory.

Participants: Patients (N = 8) with a diagnosis of ET.

Intervention: Training program consisted of 12 dexterity training sessions where each session comprised 4 tasks involving both goal-directed manual movements and hand postural exercises.

Main Outcome Measures: Testing included an ET-specific quality of life questionnaire and postural and kinetic tremor assessments. Each training session was scored to evaluate the performance.

Results: After training, improvements were observed in the performance of the 2 goal-directed tasks ($P<.01$); however, postural and kinetic tremor did not change.

Conclusions: This study suggests that dexterity training could be effective in increasing fine manual control during goal-directed movements, which are known to be the most compromised in this pathology. The absence of a decrease in tremor severity highlights the necessity for developing this novel training technique further, perhaps over a longer period of time. This study could provide guidelines for the prescription of self-directed and personalized home-based exercises and will offer clinicians a treatment that might be used as an adjuvant or an alternative to the classical pharmacotherapy.

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Essential tremor (ET) is the most common tremor-related disease[1] and is primarily characterized by kinetic and postural instability.[2] ET is expressed mainly by the hands but may also involve the head, voice, chin, and lower limbs.[3]

For many years, the treatment of this neurologic disorder has exclusively been based on pharmacologic treatments and surgery.[4,5] The use of medications often provokes significant side effects and seldom reduces tremor to asymptomatic levels,[6,7] causing a proportion of patients to withdraw from pharmacotherapy.[8] Surgical procedures can be efficacious[9,10] but are performed only in very severe and selected cases.[5] Interestingly, studies conducted on healthy individuals have reported an improvement in steadiness (a general term used to indicate a reduction of physiological tremor or an increased precision in executing tasks requiring a high degree of motor control) as a result of structured interventions involving a physical task, such as yoga, functional and manual tasks, and light-load training,[11-15] possibly suggesting that a similar result could be also obtained in the ET population. Indeed, a study investigating the differences between monozygotic twins affected by ET demonstrated that environmental factors and the activities performed during life may influence the severity of tremor.[16] Therefore, it is suggested that even though part of the difficulty in performing specific tasks is

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related to the disease, part may also be ascribed to the fact that affected patients avoid executing it because of the objective difficulty and the embarrassment related to it. As a consequence, the performance of these tasks becomes further compromised. The present study was carried out to examine the effects of a novel training approach based on hand dexterity exercises on both muscle tremor and the ability to perform precise manual tasks in patients with ET. We hypothesized that training would decrease tremor amplitude and improve performance of the trained fine manual tasks.

Methods

All participants provided informed consent to the protocol; ethical approval for this work was granted by the Ethics and Medical Research Committee, St. Vincent's University Hospital, Dublin, Ireland.

Participants

The inclusion period from the beginning of recruitment to the end of the study was 12 months. During this period, over 25 volunteers with a diagnosis of ET for at least 1 year, confirmed in accordance with the Movement Disorder Society consensus statement[17] by 2 experienced neurologists (M.H., D.B.), were recruited. Twelve volunteers took part in the study, but only 8 volunteers (5 men, 3 women; mean age, 50.9y; age range, 31−69y) completed the study. The hand reported to have the most severe tremor was examined. If tremor was subjectively symmetrical, the dominant hand was tested.

Inclusion criteria included the following: aged between 30 and 70 years and diagnosis of ET. Exclusion criteria included the following: (1) presence of other concomitant neurologic disorders; (2) significant musculoskeletal abnormalities or pain, cardiovascular disease, or respiratory disease that would interfere with study procedures or affect safety; (3) visual or cognitive impairments severe enough to render a participant unable to read the questionnaires or follow the instructions for the other measures; and (4) use of medications known to affect tremor.

Experimental design

The participants were tested 3 times at the biomechanics research laboratory at the University College of Dublin. Participants were required to abstain from alcohol, nicotine, and caffeine intake on the testing days. Each testing session included the completion of an ET-specific quality of life and tremor self-assessment questionnaire and measurements of postural and kinetic tremor. After the first testing session, all individuals were asked to maintain their normative lifestyle/physical activity and medications intake and come back after 4 weeks for a second identical testing session: this was used as the control period. After the second testing session, the participants took part in a 4-week dexterity-training program, which was immediately followed by the third testing session. All training sessions were performed at the biomechanics research laboratory at the University College of Dublin. The period from the testing session performed at week 4 to the period performed at week 8 was the intervention period. The training consisted of 12 sessions (3 times per week for 4wk); each session lasted about 30 minutes and involved 4 dexterity tasks. All the training sessions were supervised by the main investigator. The main investigator also performed all the testing and analyzed the data.

List of abbreviations:
ET essential tremor

ET-specific questionnaire

The questionnaire developed and validated by Troster et al[18] includes 30 items and is divided into 5 scales: communication (3 items), work and financial (6 items), hobbies and leisure (3 items), physical (9 items), and psychosocial (9 items).

Tremor recording

Postural tremor

The volunteer sat on a chair with the forearm in full pronation supported on a table with the hand horizontal (palm down) and the fingers loosely extended. Tremor was recorded for 20 seconds using a 3-axis accelerometer[a] fixed to the dorsal aspect of the hand with the *y* axis aligned with the third metacarpal bone. Postural recording of tremor was also performed with the arm outstretched at shoulder level.

Kinetic tremor

Kinetic tremor was recorded both at a predefined speed with the forearm supported on a table and at a free speed with the arm unsupported.

Forearm supported

The experimental setup was the same as that used for the hand postural tremor assessment. The subject held a handlebar to which a fixed load (2kg for men and 1.5kg for women) was attached. Following the rhythm of a metronome (0.17Hz), the volunteer performed 4 repetitions for each of the following wrist movements: flexion, extension, and adduction (in random order).

Forearm unsupported

The participant stood in front of a 1-m-long wire comprising 9 bends of the same size and shape while holding a 20-g wand with a 7-cm diameter metal loop at its extremity. The volunteer was instructed to start from the left and follow the bent wire shape with the wand loop engaged in the circuit trying not to touch it while performing movements of pronosupination only.

During all postural and kinetic tests, surface electromyography was recorded over the forearm extensor and flexor muscles (common fingers extensor and flexor). Silver/silver chloride bipolar electrodes[b] were placed at an interelectrode distance of 20mm. A ground electrode was placed distally on the forearm at the level of the head of the ulna.

Dexterity training

The training intervention was a novel approach tested here for the first time, to our knowledge. Each training session lasted approximately 30 minutes and consisted of 2 goal-directed dexterity tasks (exercises 1 and 4) and 2 postural tasks (exercises 2 and 3).

Exercise 1

As in the common buzz wire game, the volunteer moved a wand along a bent metal wire aiming not to touch it. When the wand